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Education in China and the World

Achievements and Contemporary Issues

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Preface

Education is considered a fundamental strategy for China's socio-economic development. Since the reform and opening-up four decades ago, education in China has undergone tremendous expansion and has continuously improved its visibility and global influence. However, due to language barriers and the complex nature of education transformation, there is a lack of accessible and reliable information on Chinese educational systems and trends for researchers outside the country, posing major obstacles to comparative studies and information exchange. It is increasingly important to provide a comprehensive, holistic, and updated analysis on education in China to the world.

Based upon this context, this book intends to serve conceptual support to develop "a modern education system with Chinese features and world standards" to promote understanding and inspire critical discussion on education development in China and around the world, and to provide implications for further developing quality education in all sectors.

This is an ambitious project to not only providing analysis covering different educational sectors from basic education to post-secondary education but also exploring critical topics in global education. This book integrates official data from China and reliable resources at home and abroad to conduct systematic statistical analysis. These resources include major global organizations, governmental statistical reports, and database at local and institutional levels. The featured analysis incorporates global comparison on key indicators to explore strengths and gaps of Chinese education with its counterparts in the world and to seek implications for enhancing quality and performance. This book also collects influential case studies and real-life stories of inspiring educators, and undergoes comprehensive literature search on current research and national policy, to provide insights into educational practices and trends in the Chinese context.

The book consists of 12 chapters in two sections. It starts with a general introduction on Chinese education system and structure in Chap. 1, providing a snapshot on basic information including sizes and scales, resources, and trends in research and development. The next six chapters (Chaps. 2–7) discuss Chinese education in six educational segments, including elementary education, middle school education, senior high school education, undergraduate education, graduate education, and professional education. The final five chapters (Chaps. 8–12) focus on educational priorities and popular topics, comparing China's development with that of its major global counterparts in terms of education systems, STEM education, mental health education, international education, and excellence initiatives to build world-class universities. Chapters 2–12 follow the same organization, covering six sections: highlighting data, excellence indicators, best practices, inspiring stories, latest research, and national policies.

This book will serve as a valuable resource for students, scholars, and policymakers in the field of education studies, as well as for the general public who are interested in Chinese education. This book is to be updated and published on a biannual basis.

Shanghai, China

Liu Niancai
Feng Zhuolin
Wang Qi

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Abbreviations

3E	Emerging engineering education
A&HC	Arts & Humanities Citation Index
AACSB	Association to Advance Collegiate Schools of Business
ADDIE	Analysis, Design, Development, Implementation, and Evaluation
ADHD	Attention Deficit Hyperactivity Disorder
AI	Artificial Intelligence
APA	American Psychiatric Association
AR	Augmented Reality
ARWU	Academic Ranking of World-Class Universities
ASD	Autism Spectrum Disorder
BFSU	Beijing Foreign Studies University
BNU-HKBU UIC	Beijing Normal University-Hong Kong Baptist University United International College
BRI	The Belt and Road Initiative
CAHE	Chinese Association of Higher Education
CAP	China's AP courses
CAS	Chinese Academy of Sciences
CBCL	Child Behavior Checklist
C-BERT	Cross-Border Education Research Team
CDE	California Department of Education
CEDEFOP	The European Center for the Development of Vocational Training
CEGEP	College of General and Professional Education
CEIBS	The China Europe International Business School
CFPS	China Family Panel Studies
CHEA	Council for Higher Education Accreditation
CICC	China International Capital Corporation Limited

CNKI	China National Knowledge Infrastructure
CPC	Communist Party of China
CSC	China Scholarship Council
CSSCI	China Social Science Citation Index
CUHKS	Chinese University of Hong Kong, Shenzhen
DEA	Data Envelopment Analysis
DKU	Duke Kunshan University
DSTI	Department of Science, Technology and Informatization
EFA	Education for All
EFMD	European Foundation for Management Development
EMBA	Executive Master's in Business Management
EQUIS	European Quality Development Accreditation System
EU	European Union
GCJC	A Guide to the Core Journals of China
GDP	Gross Domestic Product
GER	Gross Enrollment Ratio
Go8	Group of Eight
GTIIT	Guangdong Technion-Israel Institute of Technology
HEI	Higher Education Institution
HIT	Harbin Institute of Technology
ICHEI	International Center for Higher Education Innovation
I-CORE	Israel: Israeli Centers of Research Excellence
ICT	Information and Communications Technologies
IDEX	France: Initiatives of Excellence
IPO model	Input-Process-Output model
ISCED	International Standard Classification of Education
IT	Information Technology
LFS	Labor Force Survey
MBA	Master of Business Administration
MDG	Millennium Development Goal
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MOE	Ministry of Education of China
MOF	Ministry of Finance of China
MOST	Ministry of Science and Technology
MPH	Master of Public Health
NBS	National Bureau of Statistics
NCES	National Center for Education Statistics
NDRC	National Development and Reform Commission
NEAC	National Educational Attainment Categories
NHC	National Health Commission
NIES	National Institute of Education Sciences

NJU	Nanjing University
NSFC	National Natural Science Foundation of China
NTU	Nanyang Technological University
NYUS	New York University Shanghai
OBHE	Observatory on Borderless Higher Education
OECD	Organization for Economic Co-operation and Development
P.E.	Physical Education
PBL	Project-Based Learning
PISA	Program for International Student Assessment
PKU	Peking University
PPP$	Purchasing Power Parity Dollars
PSLE	Primary School Leaving Examination
QAA	Quality Assurance Agency
QS	Quacquarelli Symonds
RMB	Renminbi (Chinese yuan)
RTOS	Registered Training Organizations
R&D	Research and Development
SCI	Science Citation Index
SCIE	Science Citation Index Expanded
SDU	Shandong University
SJTU	Shanghai Jiao Tong University
SSCI	Social Sciences Citation Index
STEAM	Science, Technology, Engineering, the Arts, and Math
STEM	Science, Technology, Engineering, and Math
S&T	Science and Technology
TALIS	Teaching and Learning International Survey
TBL	Team-Based Learning
TBSI	Tsinghua-Berkeley Shenzhen Institute
THE	Times Higher Education World University Rankings
THU	Tsinghua University
Tsinghua GSST	Tsinghua Graduate School at Shenzhen
Tsinghua SIGS	Tsinghua Shenzhen International Graduate School
UC Irvine	University of California, Irvine
UCAS	University of the Chinese Academy of Sciences
UCL	University College London
UCR	University of California Riverside
UIS	UNESCO Institutes for Statistics
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNNC	University of Nottingham Ningbo China
UPE	UPE India: Universities with Potential for Excellence
USE	Unified State Examination

USTC	University of Science and Technology of China
VAS	Value-Added Services
VIE	Variable Interest Entity
VR	Virtual Reality
WHO	World Health Organization
WHU	Wuhan University
WIPO	World Intellectual Property Organization
WKU	Wenzhou-Kean University
WOS	Web of Science
WPI	World Premier International Research Center Initiative
XFU	Xi'an Fanyi University
XJTLU	Xi'an Jiaotong-Liverpool University
XJTU	Xi'an Jiaotong University

Chapter 1
Education in China: An Introduction

Feng Zhuolin and Jia Xintong

Abstract Chinese education has undergone tremendous transformation along with its socioeconomic reform in the past four decades. Education is no exception; it continues to change along with an increasingly complex and diversified world. This book provides a comprehensive overview and profound insights of education in China, to encourage further discussions on the issues and challenges confronting Chinese education and the world and to promote international understanding. The first chapter presents an overview of education in China over the past four decades and provides contextual information and analysis for the following 11 chapters. It reviews educational goals based on China's Five-Year Plans and introduces the Chinese education system and structure. It explores the development of education and research in China, and reflects developmental trends based on statistical analysis.

Keywords Educational development · Education system · Educational scale · Education resources · Scientific research

1 An Overview of the Chinese Education System

Education in China has undergone tremendous transformation along with its socioeconomic reform in the past four decades. This chapter provides a general introduction on education development and systems in China. The analysis in this section focuses on educational goals in the twenty-first century since the beginning of 2000s, as well as educational development and progress since the reform and opening-up in 1978.

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1.1 Evolving Educational Goals in the Past Two Decades

The analysis of educational goals is based on the policy documents of the Five-Year Plan for Economic and Social Development of the People's Republic of China (hereafter the Five-Year Plan) endorsed by the National People's Congress. The Five-Year Plans are formulated every five years and establish the main policy directions for further reform and development in the next five years. This series of plans set development goals for education, which reflect the educational conditions in China over time. By analyzing the goals during the past two decades, the progress and advancement of government's efforts on education can be summarized and more clearly understood.

1.1.1 The 10th Five-Year Plan (2001–2005)

Speeding up Education Development. *The 10th Five-Year Plan* was endorsed by the ninth National People's Congress in 2001 (National People's Congress, 2001). It set China's development goals from 2001 to 2005 and proposed to speed up development.

To Develop All Types of Education at All Levels. The Plan put forward to promote well-rounded education (*suzhi* education)[1] and the holistic development of students on moral, intellectual, physical, and aesthetic aspects. It prioritized the development of basic education, consolidated educational achievements in areas where nine-year compulsory education had been basically universal, and focused on developing compulsory education in economically disadvantaged areas in western China and areas with concentrations of ethnic minorities. The Plan pointed out the need to expand upper secondary education. It also proposed to implement Project 211 and strengthen a number of leading universities and disciplines in higher education. It also pushed the development of vocational education and training, early childhood education and distance learning in the Chinese context. (*ibid*).

To Further Reform the Education System. The Plan proposed to speed up the reform of schooling systems, to encourage, support, and standardize non-state actors to run schools in various forms, and establish an operating model for developing both public and private education sectors concurrently under the government's guidance. The Plan intended to deepen the reform of education management system, guarantee decision-making powers of higher education institutions (hereafter HEIs) in accordance with the law, and construct an educational system that bridges vocational and traditional education. The Plan also encouraged increased education investment, strengthened mechanism to ensure funding to the compulsory education sector, and enhanced personnel and employment system for university graduates. (*ibid*).

[1] Well-rounded education (*suzhi* education) is close to but different from the well-rounded education in the U.S., which refers to education covering multiple subject areas. This notion is close to the notion of liberal arts education in the west, and it emphasizes on a holistic approach of student development, including the development on moral, intellectual, physical, and aesthetic aspects.

1.1.2 The 11th Five-Year Plan (2006–2010)

Prioritizing Education Development. *The 11th Five-Year Plan* was endorsed by the 10th National People's Congress in 2006 (National People's Congress, 2006). It set China's development goals from 2006 to 2010 and proposed to prioritize education development.

To Reinforce and Make Compulsory Education for All. The Plan put forward to reinforce the importance of compulsory education in rural areas, reduce the dropout rate of rural students, and promote the balanced development of compulsory education in urban and rural areas. (*ibid*).

To Develop Vocational Education and Training. The Plan proposed to further develop secondary vocational education, promote various vocational skills training projects and reform the teaching methods of vocational education. (*ibid*).

To Strengthen Higher Education Quality. The Plan encouraged improving the quality of higher education, optimizing the structure and enhancing the popularization of higher education. It proposed to strengthen the development of leading universities and key disciplines. Adult education was also emphasized. (*ibid*).

To Increase Educational Investment. The Plan specified a goal of gradually raising the percentage of government expenditure on education represented in GDP (Gross Domestic Product) to 4%. It aimed to promote educational equality and it proposed to allocate more public educational resources to rural areas, the central and western regions, poor areas and minority areas. It also pointed out the need for further developing student loans system, improving the subsidy system for students at all levels of schools, and the student aid system for economically disadvantaged students. (*ibid*).

To Further Reform the Education System. The Plan emphasized the need to make clear the responsibilities of government at all levels to provide public education, form a diversified system of educational investment and establish a strict publicity system for educational charges. It put forward creating a teaching system that adapted the requirements of well-rounded education, reforming the examination and enrollment systems, and promoting the reform of teaching, curriculum, and evaluation. It also proposed to reform education management system and establish a system that had clear regulations of responsibilities and guaranteed the decision-making powers of schools. (*ibid*).

1.1.3 The 12th Five-Year Plan (2011–2015)

Further Accelerating Education Reform. *The 12th Five-Year Plan* was endorsed by the 11th National People's Congress in 2011(National People's Congress, 2011). It set China's development goals from 2011 to 2015 and proposed to further accelerate education reform.

To Develop All Types of Education at All Levels. The Plan set the goal of actively developing preschool education and raising total enrollment for children receiving one-year preschool education to 85%. It emphasized reinforcing the achievement of the popularization of compulsory education. It also sought to popularize upper secondary education during the Five-Year period, vigorously develop vocational education and emphasize rural education. It was vital to improve the quality of higher education while speeding up the construction of world-class universities, national top universities, and key disciplines. It was also important to support education for minority nationalities and speed up the development of special education and continuing education. (*ibid*).

To Enhance Education Equality. The Plan pointed out the push to distribute educational resources equally, narrow the gap of educational development between regions, and promote a balanced development of compulsory education. It emphasized education development in rural, remote or poor areas and minority areas. (*ibid*).

To Promote Well-Rounded Education. In order to promote well-rounded education, the Plan put forward to reform the content, teaching methods and assessment system of education, and reinforce the holistic development of students on moral, intellectual, physical, and aesthetic aspects. It sought to widely administer Academic Proficiency Test and Comprehensive Student Assessment in upper secondary education. In higher education, the Plan focused on carrying out projects related to the improvement of teaching quality, instructional reform, and the creation of an effective evaluation system. (*ibid*).

To Further Reform the Education System. The Plan set the goal of reforming the examination system and enrollment method, and gradually forming an effective system including classified exams, comprehensive quality assessment and diversified admission standards. The decision-making powers of schools were guaranteed and expanded, and *non-state* actors were encouraged to run schools. The Plan also claimed to follow globalization trends, strengthen international cooperation, and underscore high-quality educational resources. (*ibid*).

1.1.4 The 13th Five-Year Plan (2016–2020)

Promoting the Modernization of Education. *The 13th Five-Year Plan* was endorsed by the 12th National People's Congress in 2016 (National People's Congress, 2016). It set China's development goals from 2016 to 2020 and proposed to promote the modernization of education.

To Promote the Balanced Development of Basic Public Education. The Plan proposed to establish a unified urban and rural funding mechanism for compulsory education, take appropriate measures to ensure that state-run schools that provide compulsory education comply with educational standards, and work to raise the completion rate of compulsory education to 95%. It was important to improve the quality of teachers with emphasis on those teachers in rural areas and improve the teaching environment in rural schools. The Plan envisioned a more accessible preschool education system by proposing the targets of opening kindergartens to all children and raising the gross enrollment for children receiving three-year preschool education to 85%. It specified the goal of raising the gross enrollment of upper secondary education to over 90%. The Plan also encouraged increased availability of special needs education for groups with disabilities and promoted the development of education for ethnic minority students. (*ibid*).

To Integrate Vocational Education and Industry. The Plan aimed to improve the modern vocational education system and give momentum to training models for applied expertise and technical skills, which allow for the involvement of industry and vocational education as well as increased cooperation between schools and enterprises. It also emphasized the mutual recognition and vertical mobility between vocational education and regular education. (*ibid*).

To Train Innovators in University. The Plan attached importance to the system for ensuring the quality of higher education. It intended to manage higher education based on classifications and carry out the comprehensive reform of institutions of higher learning, implement an educational system using different methods to train academic talents and applied talents whilst combining general knowledge and major-specific knowledge. It aimed to invigorate higher education in the central and western regions. The Plan sought to ensure that all universities improve their capacity for innovation and adopt a coordinated approach to developing world-class universities and disciplines. (*ibid*).

To Build a Learning Society. The Plan emphasized developing continuing education and it envisioned a system for lifelong learning and training that was available to all members of society. The open sharing of learning resources and the development of senior citizen education were also encouraged. (*ibid*).

To Enhance the Vitality of the Reform of Education. The Plan emphasized furthering reform examination and enrollment systems as well as instructional method. It also put forth efforts to reform the professional title system for elementary and secondary school teachers nationwide and promote close integration of modern information technology with education and teaching. The decision-making powers of schools were expanded, and *non-state* actors and investors were encouraged to provide a diverse range of educational services. (*ibid*).

1.1.5 The 14th Five-Year Plan (2021–2025) and Vision 2035

Reinforcing a High-Quality Education System. *The 14th Five-Year Plan and Vision 2035* was endorsed by the 13th National People's Congress in 2021 (National People's Congress, 2021). It sets China's development goals from 2021 to 2025 and puts forward China's long-term development plan towards 2035. In education sector, it proposes to reinforce a high-quality education system.

To Promote the Equality of Basic Public Education. The most current Plan aims to consolidate the achievement of balanced development of compulsory education, promote the further development of balanced compulsory education, and close the urban–rural divide. It seeks to strengthen the ranks of teachers and improve the quality of teaching staff in rural schools. In upper secondary education, it specifies the target of raising the gross enrollment ratio to over 92%. The Plan also sets the goals of guaranteeing preschool education be more inclusive and requiring special education and specialized education be more accessible. It requires the gross enrollment of preschool education to be raised to over 90%. (*ibid*).

To Enhance the Adaptability of Vocational Education. It is important to highlight the characteristics of vocational education and train substantial talents with technical and professional skills. The Plan seeks to reform the schooling mode of vocational education and give impetus to the involvement of industry and vocational education as well as cooperation between schools and enterprises. It also emphasizes the link between vocational education and regular education. (*ibid*).

To Improve the Quality of Higher Education. The Plan puts forward managing higher education based on classifications, carrying out comprehensive reform of institutions of higher learning, and enhancing the gross enrollment ratio to 60%. It encourages the adoption of a classified approach to developing world-class universities and disciplines, and it supports the development of leading research universities. It also points out the importance of reforming the talent training system for basic disciplines and expanding the scale of graduates with professional degrees. (*ibid*).

To Improve the Quality of Teaching Staff. The Plan intends to establish a modern system of high-performing teaching staff, and places emphasis on constructing normal education bases, developing public-funded education for normal university students, and deepening the comprehensive reform of the management of teachers in elementary schools, secondary schools, and kindergartens. (*ibid*).

To Further Reform Education. The Plan aims to improve the systems and mechanisms of educational assessment and develop well-rounded education. It requires education to be covered in public welfare, and it points out to raise the spending on education and increase the efficiency of the use of educational spending. It is important to expand the decision-making powers of schools and reinforce the comprehensive reform of examination and enrollment systems. It also recommends supporting and regulating the development of non-state education and promote the cooperation with leading schools of other countries. Moreover, the Plan intends to exploit the advantages of online education, improve the system of lifelong learning and build a learning society. (*ibid*).

1.1.6 Developmental Trends of Educational Goals

Since 2001, China has experienced a period of rapid development. These five Five-Year Plans issued during this period have proposed educational goals based on China's conditions at that time and have been leading the development of education in China. The Plans have been guiding China to improve educational quality and promote educational equity. During the past 20 years, the educational goals have been increasingly detailed. Specific goals have been put forward for all types of education and at all levels. Making education for all and promoting educational reform have become a priority. Above all, the quality of education has been emphasized all the time. The fundamental criterion for measuring the quality of education is promoting the all-round development of individuals and meeting the needs of society (The State Council, 2010). The Five-Year Plans put forward specific reform measures for all types of education at all levels to guarantee the development of well-rounded education and promote the all-round development of students on moral, intellectual, physical, and aesthetic aspects. In the background, enrollment ratios of schools at all levels have been consistently rising; the emphasis on quality reflects the transformation of China's main target from scale expansion to deep development. In order to implement a comprehensive economic and social development strategy for the country, China has relied heavily on science and education, emphasized on talent development, and determined to drive development through innovation. Therefore, developing well-rounded education and continuously improving the quality of education, have been and will be the long-term development goals (Table 1).

Table 1 Educational goals in China's Five-Year plans

	The 10th Five-Year Plan (2001–2005)	The 11th Five-Year Plan (2006–2010)	The 12th Five-Year Plan (2011–2015)	The 13th Five-Year Plan (2016–2020)	The 14th Five-Year Plan and Vision 2035 (2021–2025)
Make education for all	To develop all types of education at all levels	To reinforce and make compulsory education for all	To develop all types of education at all levels To enhance education equality To promote well-rounded education	To promote the balanced development of basic public education To build a learning society	To promote the equality of basic public education To improve the quality of teaching staff
Educational reform	To further reform the education system	To further reform the education system	To further reform the education system	To enhance the vitality of the reform of education	To further reform education
Education resources		To increase educational investment			
Higher education		To strengthen higher education quality		To train innovators in university	To improve the quality of higher education
Vocational education		To develop vocational education and training		To integrate vocational education and industry	To enhance the adaptability of vocational education

1.2 The Education System

China's education system covers preschool education, compulsory education, upper secondary education, and higher education (Fig. 1). Compulsory education includes elementary education and lower secondary education; higher education includes undergraduate education and graduate education.

1.2.1 Preschool Education

In China, children usually enroll in preschool at the age of two or three and leave preschool at the age of six. Preschool education is not compulsory education.

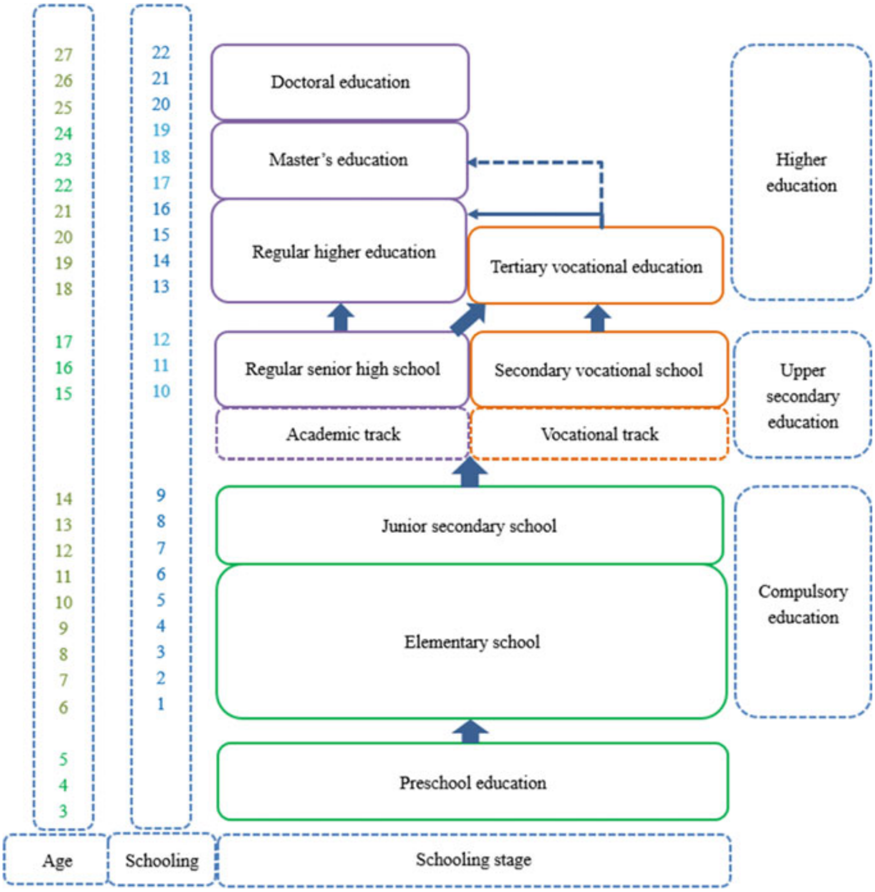

Fig. 1 The education system of China. *Source* Adapted from OECD (2016)

However, the government takes a proactive role in promoting preschool accessibility. Public preschool and private preschool are both important in China. In 2021, 48.11% of preschool students were in private preschools (Ministry of education [MOE], 2022).

1.2.2 Compulsory Education

China adopts a system of nine-year compulsory education, which shall be received by all school-age children and adolescents. It generally includes six years of elementary education and three years of lower secondary education. However, there is some variation between regions with a small number of them having a "5 + 4" rather than a "6 + 3" structure. In public schools, compulsory education is publicly funded and is implemented uniformly by the State; no tuition or miscellaneous fees are charged, and the State shall establish a guaranteed mechanism for operating funds for compulsory education. Elementary education and lower secondary education are also provided by private schools, while they are not free of charge. In 2021, 10.60% of compulsory education students were in private schools (MOE, 2022). In compulsory education, curricula and standards are set by MOE and then implemented nationwide by provincial and municipal governments. Article Three of *Compulsory Education Law of the People's Republic of China* stipulates that well-rounded education shall be carried out to improve the quality of education and enable children and adolescents to achieve all-round development—morally, intellectually, and physically—so as to lay the foundation for cultivating well-educated and self-disciplined workforce with high ideals and moral integrity (National People's Congress, 2018a).

1.2.3 Upper Secondary Education

After compulsory education, students can choose whether to continue to upper secondary education. Upper secondary education is three years in duration and includes two types of schools: regular senior high schools and secondary vocational schools. Regular senior high school represents academic track, while secondary vocational school represents vocational track.[2] Students complete a senior high school entrance examination (*zhongkao*) before entering upper secondary schools. Students are assigned to different types of upper secondary schools based upon entrance examination results. In China, upper secondary education is mostly publicly funded. In 2021, 17.29% of regular senior high school students and 20.40% of secondary vocational school students were in private schools (MOE, 2022).

[2] Secondary vocational school includes regular specialized high schools (*putong zhongzhuan*), vocational high schools (*zhiye gaozhong*), adult specialized high schools (*chengren zhongzhuan*), and technical schools (*jishu xuexiao*).

1.2.4 Higher Education

According to Article Two of *Higher Education Law of the People's Republic of China*, higher education in China is defined as "education that is carried out after the completion of upper secondary education" (National People's Congress, 2018b). It is a general term inclusive of postsecondary education provided by academies, universities, colleges, vocational institutions, institutes of technology and certain other collegiate-level institutions, including vocational schools, trade schools, and career colleges that award academic degrees or professional certifications (Yu et al., 2012). In China, the bachelor's, master's, and doctoral degrees are the three officially sanctioned higher education degrees. China's higher education includes undergraduate education and graduate education. Within the undergraduate education system, regular higher education is the more academic route and tertiary vocational education is the more vocational route; through examination, students of tertiary vocational education can transfer to regular higher education. Students of both routes have opportunities to obtain bachelor's degree. Graduate education system includes master's education and doctoral education. Admissions to undergraduate education are based on students' scores of college entrance examination (*gaokao*), and admissions to graduate education are based on students' results of entrance examinations. In China, higher education is mostly publicly funded. In 2021, 24.19% of undergraduate students were in private HEIs (MOE, 2022).

1.3 The Educational Development Since the Reform and Opening-Up in 1978

1.3.1 Focusing on Developing Education

Providing education with concentrated strength and focus has always been the most obvious feature of "holding a large scale of education in a poor country". In order to speed up reform within the shortest period, China adopted a plan of concentrating limited educational resources on selected schools and key fields and concentrating efforts on training in-demand skills and occupations.

Key Elementary and Secondary Schools. In January 1978, MOE stipulated the objectives, tasks, plans, enrollment methods, and leadership of key elementary and secondary schools. In October 1980, MOE sought to build approximately 700 key secondary schools as first-class, high-quality and distinctive schools with good studying habits. In July 1995, National Education Commission (the predecessor of MOE) evaluated and published a list of around 1,000 model regular senior high schools.

Projects 211 and 985 to Develop Higher Education Excellence. In 1993, the State proposed that the central government and local authorities should concentrate on running about 100 key universities and a number of core disciplines. In November

1995, Project 211 officially launched. In 1998, President Jiang Zemin put forward to establish a number of world-class universities in China. In 1999, Project 985 officially launched. These projects aimed to develop a number of excellent universities and enhance the strength of higher education.

Key Vocational Schools. In order to improve the quality of vocational education, in January 1995, the State Council proposed to carry out the evaluation and accreditation of national key secondary vocational schools, and 296 key vocational schools were selected nationwide. (Zhang, 2018).

1.3.2 Governing Education Development Through Laws and Regulations

Governing education development through legislation reflects the advancement of modernization in the field of education.

Within the compulsory education sector, Chinese government proposed the implementation of nine-year compulsory education in 1985, and then enacted *Compulsory Education Law of the People's Republic of China* in 1986. It took 25 years for China to develop compulsory education from the all-round "universal" stage to the quality improvement stage. As a developing country with a large population, China has realized the target of requiring nine-year compulsory education for all.

China established its higher education academic degree system in 1980. *Higher Education Law of the People's Republic of China* promulgated in 1998 formulated a degree system including bachelor's degree, master's degree, and doctoral degree, and it has become one of the most important laws to promote the development of higher education.

In the areas of preschool education, special education, and vocational education, the State Council approved the first administrative regulation of preschool education in 1989. China promulgated the first special regulation on education for the disabled in 1994 and implemented *Vocational Education Law of the People's Republic of China* in 1996. (*ibid*).

1.3.3 Taking Efficiency and Equity into Consideration

With the development of education in China and the basic realization of equitable education as a starting point, the focus of education reform and development has been gradually converted from the equity of entry to the equity of educational process. Additional efforts have been made to improve the insufficient and imbalanced development of education.

Resuming College Entrance Examinations and Relaxing Restrictions on the Identity of Candidates. In 1977, the college entrance examinations were resumed. Groups including workers, peasants, and fresh high school graduates could sit for the exam as long as they match the requirements, and this change helped improve the equity of talent selection.

Eliminating the Drop-Out of Girls and Promoting Equal Education Opportunities for Men and Women. The Chinese government has actively taken actions to eliminate the dropping-out of girls and worked to effectively guarantee school-age girls' rights to receive education.

Ensuring School-Age Children's Right to Receive Compulsory Education. Chinese government has been working to provide more policy support and taking measures to protect school-age children's right to receive nine-year compulsory education.

Effectively Narrowing the Gap between Regions, Urban and Rural Areas, Schools, and Groups. To narrow the educational gap between the eastern, central, and western regions, additional financial investment has been dedicated to the central and western regions, and the revitalization plans for education in the central and western regions have been implemented. To narrow the educational gap between urban and rural areas, reforms have been implemented targeting low performing rural schools and providing additional support to rural teachers. To narrow the gap between schools, low-performance schools have been given advantages in educational funding, capital construction, the acquisition of teaching equipment, and the adjustment in teaching personnel. To narrow the gap between groups, the government has vigorously encouraged and supported disadvantaged groups to receive education. (*ibid*).

1.3.4 Encouraging and Supporting Education Diversification

Education is a common cause that unites the whole of society. It is important to encouraging non-state actors to participate in and support the development of education. Running schools by *non-state* actors can not only ease the shortage of educational funding, but also improve the vitality of education, meet diversified educational demands, and promote the health and scientific development of education.

A series of policies provides support and encouragement to non-state actors to run schools. Article 19 of *Constitution of the People's Republic of China* promulgated in 1982 stipulated, "the State encourages collective economic organizations, state enterprises and institutions, and other *non-state* actors to organize education in accordance with the law" (National People's Congress, 1982). In 1985, Chinese central government put forward to arouse the enthusiasm of governments at all levels, teachers, students, employees, and social actors through reform. In July 1997, the State Council endorsed regulations to support and regulate *non-state* actors to run schools. In September 2003, *Private Education Promotion Law of the People's Republic of China* was promulgated and implemented, marking a new stage of legalization for China's non-public educational sector. In 2016, the Standing Committee of the National People's Congress and the State Council issued regulations to actively guide *non-state* actors to run non-profit private schools.

In addition, non-state actors have been invited to engage in developing education at all levels. Along with making nine-year compulsory education for all, Project Hope (*Xiwang Gongcheng*) and Spring Bud Project (*Chunlei Jihua*) sprung up. Project Hope, launched by China Youth Development Foundation in 1989, sought to build

Hope Elementary School (*Xiwang Xiaoxue*) and subsidize students in poverty. The Spring Bud Project was initiated by China Children and Teenagers' Foundation in 1989 to improve education for girls from impoverished families. Currently in upper secondary education sector, the proportion between public and private education is around 8:2. (*ibid*).

2 Educational Scale in China

Based on *The 2020 Overview of Educational Achievements in China* and *The 2021 Statistical Bulletin on National Education Development* published by MOE, this section depicts the scale of China's education from the following four aspects: literacy level, number of schools, number of students, and number of full-time teachers.[3]

2.1 Literacy Level

Literacy level is analyzed from the following four aspects: the number of students in elementary, junior secondary schools, and upper secondary education for every 100,000 people; the enrollment ratio in elementary, junior secondary schools, upper secondary education, and higher education; the proportion of elementary and junior secondary school graduates continuing on to the next education level; the ratio of enrollment to graduation at compulsory education level. The net enrollment ratio in elementary school and the gross enrollment ratio in junior secondary school in 2020 consistently maintained at a high level, and the gross enrollment ratio in higher education reached 57.80% in 2021, which was the highest ever (Table 2).

2.2 Number of Schools by Educational Sector and Level

Table 3 shows the number of schools by educational sector and level in 2021. The number of preschools reached 294,800, which was the largest ever. The number of schools of compulsory education was the second largest, with elementary schools representing three fourths and junior secondary schools representing one fourth. In upper secondary education, the number of regular senior high schools was larger than that of secondary vocational schools. In higher education, the number of HEIs reached 3,012 and seven of them are world-class universities.

[3] The statistics of this section does not include data on Hong Kong and Macao Special Administrative Regions and Taiwan Province.

Table 2 The literacy level of Chinese students

The literacy level of Chinese students	
The number of students in elementary schools for every 100,000 people	7,661
The number of students in junior secondary schools for every 100,000 people	3,510
The number of students in upper secondary education for every 100,000 people	2,948
The net enrollment ratio in elementary school	99.96%
The gross enrollment ratio in junior secondary school	102.50%
The gross enrollment ratio in upper secondary education (2021)	91.40%
The gross enrollment ratio in higher education (2021)	57.80%
The proportion of elementary school graduates continue onto junior secondary school	99.50%
The proportion of junior secondary school graduates continue onto upper secondary education	94.60%
The ratio of enrollment to graduation at compulsory education level (2021)	95.40%

Source MOE (2021, 2022)
Notes
1. Net enrollment ratio: the percentage of the total number of students (age groups are specified) in a given education level represents in the population of the age group specified by that given education level
2. Gross enrollment ratio: the percentage of the total number of students (age groups are not specified) in a given education level represents in the population of the age group specified by that given education level, as informal age groups (low-age and over-age) are included, the figure can be over 100%
3. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults
4. The latest data of 2021 are listed wherever is available, while the other data are of 2020

2.3 Number of Students by Educational Sector and Level

Table 4 shows the number of students by educational sector and level in 2021. The number of compulsory education students reached over 158 million and the number of higher education students reached 44.3 million, which were the largest ever. In upper secondary education, the number of regular senior high school students was larger than that of secondary vocational school students.

2.4 Number of Full-Time Teachers by Educational Sector and Level

Table 5 shows the number of full-time teachers by educational sector and level in 2021. The number of full-time teachers in compulsory education was the largest among all categories. In 2021, excluding upper secondary education, the number of every category was the largest ever.

Table 3 Number of schools by educational sector and level (2021)

Educational sectors and levels	Number of schools
Compulsory education:	207,200
Elementary school	154,300
Junior secondary school	52,900
Upper secondary education:	21,894
Regular senior high school	14,600
Secondary vocational school	7,294
Higher education	3,012
World-class university	7
Non-world-class university	3,005
Preschool	294,800
Special school	2,288
Private school	185,700

Source MOE (2022); Shanghai Ranking (2021); QS (2021); THE (2021)

Notes

1. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. The 2021 data of upper secondary education do not include the data of senior high schools for adults
2. Secondary vocational school includes regular specialized high schools, vocational high schools, adult specialized high schools, and technical schools. The 2021 data of secondary vocational school do not include the data of technical schools
3. World-class university refers to the universities in the Chinese mainland that have entered the top 100 of any of Academic Ranking of World Universities (ARWU), QS World University Rankings (QS), and Times Higher Education World University Rankings (THE) in 2021. World-class universities include Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, University of Science and Technology of China, Fudan University, and Sun Yat-Sen University
4. Private school refers to all levels of schools that are not state-run, which includes preschools, elementary schools, junior secondary schools, regular senior high schools, secondary vocational schools, and regular HEIs

3 Educational Resources in China

Based on *The 2020 Statistical Bulletin on Education Spending* co-released by MOE, National Bureau of Statistics (NBS), and Ministry of Finance (MOF) in 2021, and *The 2020 Overview of Educational Achievements in China* published by MOE in 2021, this section depicts educational resources in China from the following four

Table 4 Number of students by educational sector and level (2021)

Educational sectors and levels	Number of students (in thousand)
Compulsory education:	158,184
Elementary school	108,000
Junior secondary school	50,184
Upper secondary education:	39,168
Regular senior high school	26,050
Secondary vocational school	13,118
Higher education	44,300
World-class university	352
Non-world-class university	43,948
Preschool	48,052
Special school	920
Private school	56,288

Source MOE (2022); ShanghaiRanking (2021); QS (2021); THE (2021); Tsinghua (2022); PKU (2022); ZJU (2022); SJTU (2022); USTC (2022); Fudan (2022); SYSU (2022)

Notes

1. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. The 2021 data of upper secondary education do not include the data of senior high schools for adults
2. Secondary vocational school includes regular specialized high schools, vocational high schools, adult specialized high schools, and technical schools. The 2021 data of secondary vocational school do not include the data of technical schools
3. World-class university refers to the universities in the Chinese mainland that have entered the top 100 of any world university ranking of ARWU, QS, and THE in 2021. World-class universities include Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, University of Science and Technology of China, Fudan University, and Sun Yat-Sen University
4. Private school refers to all levels of schools that are not state-run, which includes preschools, elementary schools, junior secondary schools, regular senior high schools, secondary vocational schools, and regular HEIs

aspects: the overall spending on education, the general public expenditure on education, the general public operating expenditure on education per student, and school infrastructure.[4]

3.1 *Overall Spending on Education*

Table 6 shows China's overall spending on education in 2020. The overall spending on education nationwide reached US$812.79 billion, the spending on education from

[4] The statistics of this section does not include of data on Hong Kong and Macao Special Administrative Regions and Taiwan Province.

Table 5 Number of full-time teachers by educational sector and level (2021)

Educational sectors and levels	Number of full-time teachers (in thousand)
Compulsory education	10,572
Elementary school	6,601
Junior secondary school	3,971
Upper secondary education	2,723
Regular senior high school	2,028
Secondary vocational school	695
Higher education	1,885
World-class university	26
Non-world-class university	1,859
Preschool	3,191
Special school	69

Source MOE (2022); ShanghaiRanking (2021); QS (2021); THE (2021); Tsinghua (2022); PKU (2022); ZJU (2022); SJTU (2022); USTC (2022); Fudan (2022); SYSU (2022)

Notes

1. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. The 2021 data of upper secondary education do not include the data of senior high schools for adults
2. Secondary vocational school includes regular specialized high schools, vocational high schools, adult specialized high schools, and technical schools. The 2021 data of secondary vocational school do not include the data of technical schools
3. World-class university refers to the universities in the Chinese mainland that have entered the top 100 of any world university ranking of ARWU, QS, and THE in 2021. World-class universities include Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, University of Science and Technology of China, Fudan University, and Sun Yat-Sen University
4. Private school refers to all levels of schools that are not state-run, which includes preschool, elementary school, junior secondary school, regular senior high school, secondary vocational school, and regular HEIs

national budget reached US$657.61 billion, and the spending on education from national budget represented 4.22% in China's GDP in 2020.

3.2 General Public Expenditure on Education

Table 7 shows China's general public expenditure on education in 2020. The general public expenditure on education reached US$556.49 billion and it represented 14.78% in national public budget in 2020.

Table 8 shows the general public expenditure on education per student in schools by educational sector and level in 2020.The figure for higher education was the highest, while preschool was the lowest. The expenditures on elementary and junior

Table 6 China's overall spending on education (2020)

China's overall spending on education	
Overall spending on education nationwide	RMB5.30 trillion (US$812.79 billion)
Spending on education from national budget	RMB4.29 trillion (US$657.61 billion)
Spending on education from national budget as a percentage of GDP	4.22%

Source MOE et al. (2021)
Notes
1. Spending on education from national budget mainly comes from government finances, government-managed funds, businesses running schools in partnership with the government, school-run businesses, and not-for-profit organizations
2. China's GDP in 2020 is RMB101.60 trillion (US$15.57 trillion)
3. The exchange rate of the data year is used

Table 7 China's general public expenditure on education (2020)

China's general public expenditure on education	
General public expenditure on education	RMB3.63 trillion (US$556.49 billion)
General public expenditure on education as a percentage of national public budget	14.78%

Source MOE et al. (2021)
Notes
1. General public expenditure on education includes operating expenditure, investments in infrastructure, and education surcharge
2. China's national public budget in 2020 is RMB24.57 trillion (US$3.77 trillion)
3. The exchange rate of the data year is used

secondary school in rural area were lower than the average number of that education level.

3.3 General Public Operating Expenditure on Education Per Student

Table 9 shows the general public operating expenditure on education per student in schools by educational sector and level in 2020. The expenditure on higher education was the highest, while preschool was the lowest. The figures for elementary and junior secondary school in rural area were slightly lower than the average number of that education level.

Table 8 General public expenditure on education per student (2020)

Educational sectors and levels	General public expenditure on education per student (US$)
Preschool	1,442.28
Elementary school	1,889.77
Elementary school in rural area	1,768.81
Junior secondary school	2,728.56
Junior secondary school in rural area	2,410.92
Regular senior high school	2,861.63
Secondary vocational school	2,673.90
Higher education	3,434.14

Source MOE et al. (2021)
Notes The exchange rate of the data year is used

Table 9 General public operating expenditure on education per student (2020)

Educational sectors and levels	General public operating expenditure on education per student (US$)
Preschool	1,324.94
Elementary school	1,786.16
Elementary school in rural area	1,713.24
Junior secondary school	2,549.21
Junior secondary school in rural area	2,316.07
Regular senior high school	2,634.07
Secondary vocational school	2,394.68
Higher education	3,206.05

Source MOE et al. (2021)
Notes The exchange rate of the data year is used

3.4 School Infrastructure

Table 10 illustrates the space utilization and equipment in schools by educational sector and level in 2020. The average value and average number of instructional equipment per student increased with the level of education. It is worth noting that the average value of teaching and scientific research equipment per student at secondary vocational schools was higher than that of regular senior high school.

Table 10 The space utilization and equipment in schools by educational sector and level (2020)

Educational sectors and levels	Space utilization and equipment	
Elementary school	The average value of teaching and scientific research equipment per student	RMB1,809 (US$277.25)
	The average number of instructional computers per 100 students	11.80
	The proportion of schools with a local area network (LAN)	70.40%
Junior secondary school	The average value of teaching and scientific research equipment per student	RMB2,835 (US$434.49)
	The average number of instructional computers per 100 students	16.30
	The proportion of schools with a local area network (LAN)	77.40%
Regular senior high school	The average floor area in educational institutions per student	24.10 m^2
	The average value of teaching and scientific research equipment per student	RMB4,738 (US$726.14)
	The average number of instructional computers per 100 students	20.50
Secondary vocational school	The average floor area in educational institutions per student	19.30 m^2
	The average value of teaching and scientific research equipment per student	RMB7,829 (US$1,199.87)
	The average number of instructional computers per 100 students	23.10
Higher education institutions (HEIs)	The average school floor area in educational institutions per student in regular HEIs	26 m^2
	The average value of teaching and scientific research equipment per student in regular HEIs	RMB16,522 (US$2,532.15)
	The average number of instructional computers per 100 students in regular HEIs	25.10
	The average number of online courses provided by regular HEIs	428

Source MOE (2021)

Notes

1. The exchange rate of the data year is used
2. Self-owned properties and rented properties are included in the data of HEIs and secondary vocational schools in terms of their floor area in educational institutions, teaching and scientific research equipment, and instructional computers; for the same data as indicated above, technical schools are excluded from secondary vocational schools

4 Scientific Research in China

4.1 Scientific Research Development at China's HEIs

Over the past four decades since reform and opening-up, China has gradually established a national innovation system. During this time, HEIs have become more and more important in scientific and technological innovation. This section reviews the technological policies in five important stages since 1978.

4.1.1 Stage One: Restoring the Scientific Research Function of HEIs (1978–1984)

In 1978, Chinese central government formulated the outline of national plan for science and technology development during the period from 1978 to 1985. Deng Xiaoping, the leader of China at the time, put forward strategies including "science and technology are elementary productive force" and "the key of the four modernizations is the modernization of science and technology", which promote the restoration and development of science and technology system. During this period, the function of scientific research of HEIs has gradually been restored. In 1977, Deng Xiaoping expressed support for increased research activity by stating, "key higher education institutions are significant in scientific research and should undertake more scientific research tasks." Since then, HEIs have been allocated with budget appropriation for scientific research from national funds, marking an official change and the restoration of HEI's role in scientific research. In 1978, National Education Commission, National Science Commission (the predecessor of Ministry of Science and Technology [MOST]), and MOF decided to allocate RMB30 million from "the three types of expenses of science and technology" (which include the expense of new product experiment, the expense of semi-plant test, and key scientific research subsidies) to HEIs, in order to promote important scientific research and experiment. Scientific research has been included in the operating expenditure on higher education since 1979, and the appropriation for scientific research was RMB14.15 million that year. In 1985, the scientific research fund for HEIs was nearly RMB600 million (Yin & Shen, 2005).

4.1.2 Stage Two: Establishing Research Universities (1985–1994)

In 1985, Chinese government advocated, "higher education institutions and Chinese Academy of Sciences take important responsibilities for basic research and applied research. Basic research and applied research should be tightly combined with workforce needs. Higher education institutions that meet certain conditions are encouraged to construct distinctive and effective research institutes". In September 1991, the State Council pointed out that, "higher education institutions should pay great attention to scientific research work and regard it as basic tasks", "higher education institutions with a large number of key disciplines, important assignments of training graduate students, and good foundations for teaching and scientific research, should be developed into the center of education and the center of scientific research. They should take major responsibilities for scientific and technological tasks and train high-level talents for the country. They should also take the lead in improving China's strength of science and technology and the quality of higher education" (Yin, 2005). In order to promote the development of scientific research in HEIs in the early 1990s, the Chinese government developed policy-level plans to invest special funds to construct research universities. In December 1991, National Planning Commission (the predecessor of National Development and Reform Commission [NDRC]), National Education Commission, and MOF proposed to the State Council that they all "agree to the country's decision of establishing key universities and key disciplines that are required for national economic and social development". In 1993, *The Outline of China's Education Reform and Development* suggested the central government and local governments should jointly establish 100 strategic universities. All of these policies made a foundation for the formulation of the ensuring Project 211 of higher education (MOE, 2008).

4.1.3 Stage Three: Implementing National Initiatives to Further Develop Research Universities (1995–2004)

To reinforce Chinese higher education's competitiveness in the global stage, Chinese government implemented a series of special plans to support the establishment of research universities. In November 1995, the overall plan for Project 211 was published, which suggested the central government and local governments should jointly establish around 100 key universities and a number of key disciplines that reach world-class level (MOE, 2008).

In December 1998, MOE put forward a goal of developing a number of key universities and key disciplines into world-class level in the following 10–20 years. In January 1999, the State Council ratified Project 985 of higher education.

During the period of the *10th Five-Year Plan (2001–2005)*, China allocated considerable funding for the construction of Project 211 and Project 985. In 2001, the Education Work Conference proposed to strengthen the development of leading universities and key disciplines, make key discipline as the core and speed up the development (MOE, 2008). In 2004, the second phase of Project 985 was launched, which expanded the university list and a total of 39 universities were included and put forward five aspects of goals in developing world-class universities: mechanism innovation, talent training, platform establishment, supportive conditions, and international communication and cooperation (Yuan & Guo, 2012).

After nearly a decade of development, a number of Chinese HEIs had followed the direction of developing world-class universities and markedly improved their level of scientific research. By investigating the scale and influence of scientific research of China's research universities from 1997 to 2006, it can be seen that the amount of scientific research achievements of China's research universities had increased by nearly five times during decade, and the influence of scientific research achievements had continued to be enhanced during the period, while the turning point of scientific research output is basically the same as the time point of constructing Project 985 (Zhu & Liu, 2009).

4.1.4 Stage Four: Serving National Innovation System (2005–2014)

In 2005, the State Council published an outline of national plan for science and technology development in the period of 2006–2020 and proposed the general goal of "establishing national innovation system" (MOST, 2006).

While establishing a national innovation system, universities, especially research universities, were required to realize new targets. The State Council pointed out, "universities are important base of training high-level innovative talents, and they are one of the main forces of basic research and high-tech innovation." Based on the demand of establishing national innovation system, Chinese universities were not only required to improve the strength of scientific research, but also required to form an innovation system collaboratively with enterprises and government (MOST, 2006). In 2008, NDRC, MOE, and MOF launched the third phase of Project 211, and it aimed at building China into an innovative country, as it strengthened the construction of key disciplines, innovative talents and personnel, and the public service system of higher education (MOST, 2006). MOE and other related ministries proposed the 2011 Plan in 2012. The 2011 Plan originated from "the urgent demand of the country and the requirement of reaching world-class level", it was based on the trinity of improving the innovative capacity of talents, disciplines, and scientific research, and it aims at improving the quality of higher education and serving the development of economy and society (MOE, 2014).

4.1.5 Stage Five: Further Developing World-Class Universities and Disciplines (2015-Present)

In October 2015, the State Council issued *The Overall Plan for Promoting the Construction of World-Class Universities and World-Class Disciplines* and proposed to "promote a number of leading universities and disciplines to get into the first class or the front class in the world" (the State Council, 2015). It put forward the following goals: to develop a number of world-class universities and first-class academic disciplines by 2020; to have more universities and disciplines among the world's best and to enhance the country's overall higher education capacity by 2030; and to lead the number, quality and capacity of world-class universities and disciplines among the world's best, becoming a higher education powerhouse by 2050 (the State Council, 2015).

In September 2017, MOE, MOF, and NDRC published the list of the Double World-Class Project, which selected 42 universities aiming for world-class status and 140 universities that were designated to develop world-class disciplines (MOE et al., 2017). In February 2022, the list of the second round of the Double World-Class Project was published, which selected more than 400 disciplines from 147 universities (MOE et al., 2022). The purpose of the Double World-Class Project is to support the national strategy of innovation-driven development, improve the level of educational development, strengthen the core competitiveness of the country, and realize the great development of China from a large country in higher education to a powerful country in higher education.

4.2 Research Performance of China's HEIs

4.2.1 Science and Technology (S&T) Research Output

Scientific and technological achievements refer to the output of scientific and technological research created by scientific and technological personnel. The scientific and technological achievements at China's HEIs mainly include four categories: scientific and technological books, academic papers, international projects completed and approved, and intellectual property rights and patents.

In 2021, China's HEIs published 13,740 scientific and technological books; published 1,129,917 academic papers, of which 571,696 were published on foreign academic journals. A total of 3,271 international projects were completed and approved. In 2021, China's HEIs applied 328,896 patents, of which 268,450 were authorized and 15,169 were sold. The number of other intellectual property rights (include software registration, integrated circuit design registration, new animal and plant varieties registration, and national new drug registration, etc.) that China's HEIs acquired in 2021 was 34,915. (Department of Science, Technology and Informatization [DSTI], 2022).

4.2.2 Innovative Talent Development in S&T

Scientific and technological talents refer to the personnel who directly participate in scientific and technological activities in related institutions or departments and are paid, including scientists, engineers, technicians, and auxiliary personnel (UNESCO, 2014). In statistics, the scientific and technological workforce at China's HEIs can be divided into three categories: teaching and scientific research personnel, R&D personnel, and personnel of scientific and technological services.

In 2021, the total number of scientific and technological workforce of China's HEIs was approximately 1.85 million. The number of teaching and scientific research personnel was 1,268,970, accounting for around 69%; the number of R&D personnel was 516,101, accounting for around 28%; and around 3% of the total workforce was personnel of scientific and technological services, with the number of 67,038. (DSTI, 2022).

4.2.3 S&T Innovation Platforms

The scientific and technological innovation platforms at China's HEIs mainly include national key laboratories, national engineering technology research centers, key laboratories of MOE, key laboratories on provincial and ministerial levels, engineering technology research centers on provincial and ministerial levels, and research institutes built by schools. (Wu & Tang, 2006).

4.2.4 S&T Projects at China's HEIs

Scientific and technological projects refer to the research and experiment and development works that aim at solving complex and comprehensive scientific and technological problems. Scientific and technological projects at China's HEIs mainly include three categories: basic research project, applied basic research project, and experiment and development project.

In 2021, the total number of scientific and technological projects of China's HEIs was 696,714. The number of basic research projects was 303,197, accounting for around 44% of the total; the number of applied basic research projects was 328,869, accounting for around 47%; the number of experiment and development projects was 64,648, accounting for around 9%. (DSTI, 2022).

5 Trends of Chinese Education

5.1 Trends in Educational Scale

Based on *The Overview of Educational Achievements in China* and *The Statistical Bulletin on National Education Development* published by MOE from 2012 to 2022, this section analyses changes in education scale in the Chinese mainland from the following four aspects: gross enrollment ratios in schools by educational sector and level, number of schools, number of students, and number of full-time teachers.

5.1.1 Gross Enrollment Ratio

Figure 2 shows the enrollment ratios of schools by educational sector and level during the period from 2011 to 2021. The figures for elementary school and junior secondary school remained stable on a high level. The figures for preschool and upper secondary education consistently increased during the period. It is noticeable that the gross enrollment ratio of higher education rose rapidly and the figure for 2021 doubled that for 2011.

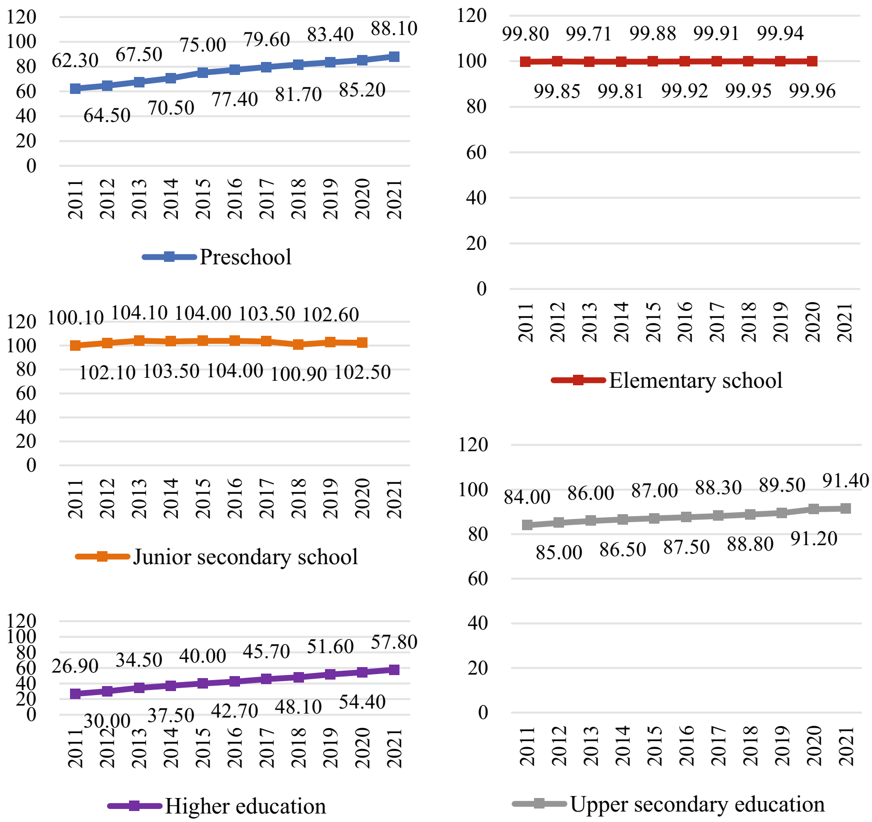

Fig. 2 Gross enrollment ratio (2011–2021) (%). *Source* MOE (2012–2022). *Notes* 1. The enrollment ratio of elementary school is net enrollment ratio. 2. Gross enrollment ratio: the percentage of the total number of students (age groups are not specified) in a given education level represents in the population of the age group specified by that given education level, as informal age groups (low-age and over-age) are included, the figure can be over 100%. 3. Net enrollment ratio: the percentage of the total number of students (age groups are specified) in a given education level represents in the population of the age group specified by that given education level. 4. The official 2021 data of elementary school and junior secondary school are not published yet

5.1.2 Number of Schools

Figure 3 shows the total number of all types of schools at all levels in China during the period from 2011 to 2021. The number declined slightly in the period from 2011 to 2015, then it noticeably went up after 2016, and slightly declined in 2021.

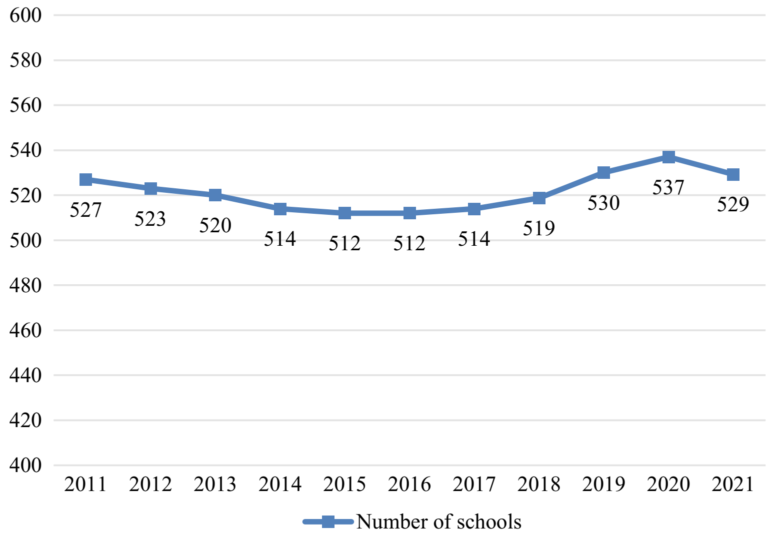

Fig. 3 Number of schools (2011–2021) (in thousand). *Source* MOE (2012–2022)

5.1.3 Number of Schools by Educational Sector and Level

Figure 4 shows the number of schools by educational sector and level in China during the period from 2011 to 2021. The numbers of preschool significantly increased during the period, while the figures for elementary school consistently fell. The figures for junior secondary schools, upper secondary education, higher education, and special education were the lowest four categories, and generally remained stable during the period.

5.1.4 Number of Students

Figure 5 illustrates the total number of students in all types of schools at all levels in China during the period from 2011 to 2021. The figures fluctuated during the period from 2011 to 2016, and rapidly rose after 2016.

5.1.5 Number of Students by Educational Sector and Level

Figure 6 shows the number of students in schools by educational sector and level in China during the period from 2011 to 2021. The figures for elementary school remained stable as the highest among all categories during the period. The number of preschool students went up steadily, and the number of junior secondary school fluctuated between 43,000 thousand and 51,000 thousand. Upper secondary education

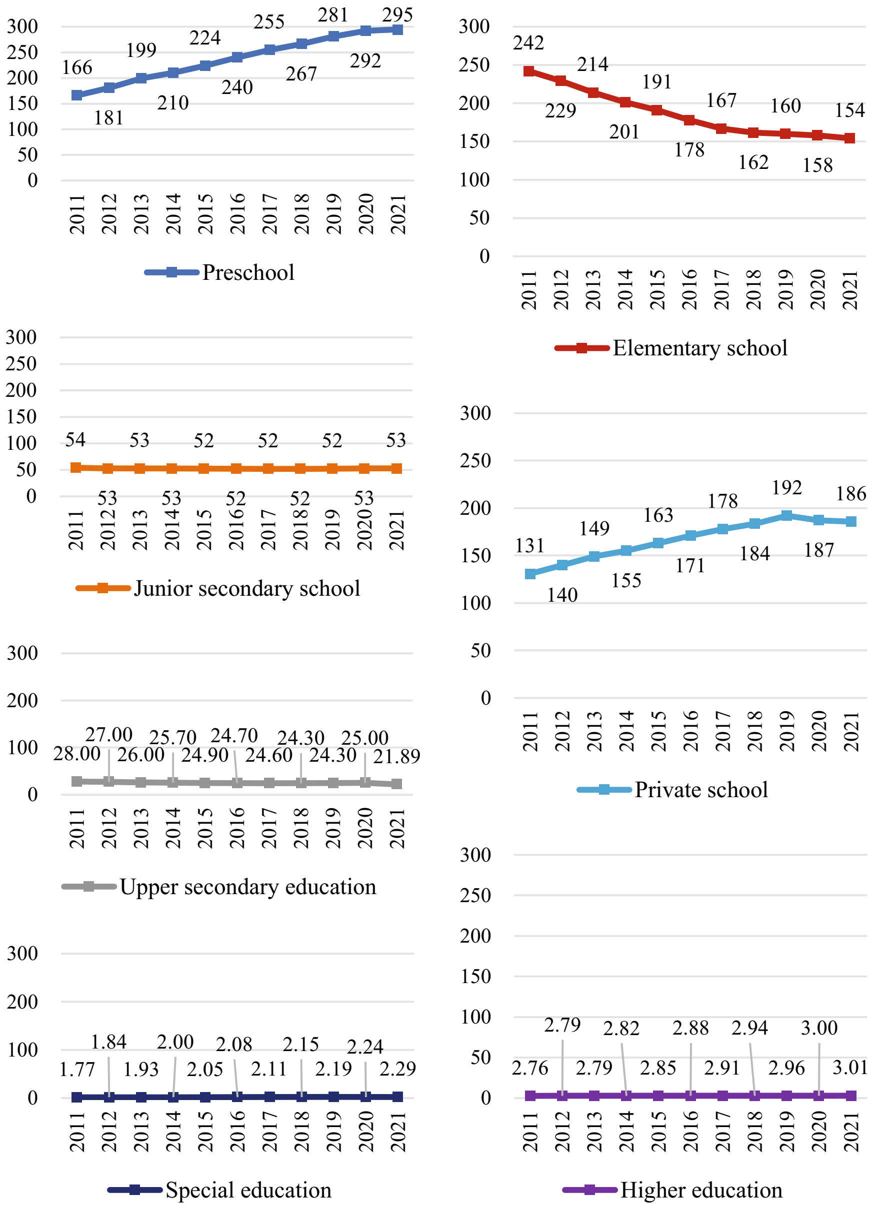

Fig. 4 Number of schools by educational sector and level (2011–2021) (in thousand). *Source* MOE (2012–2022). *Notes* 1. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. In 2021, the data of upper secondary education do not include the data of senior high schools for adults, and the data of secondary vocational school do not include the data of technical schools. 2. Private school refers to all levels of schools that are not state-run, which includes preschool, elementary school, junior secondary school, regular senior high school, secondary vocational school, and regular HEIs

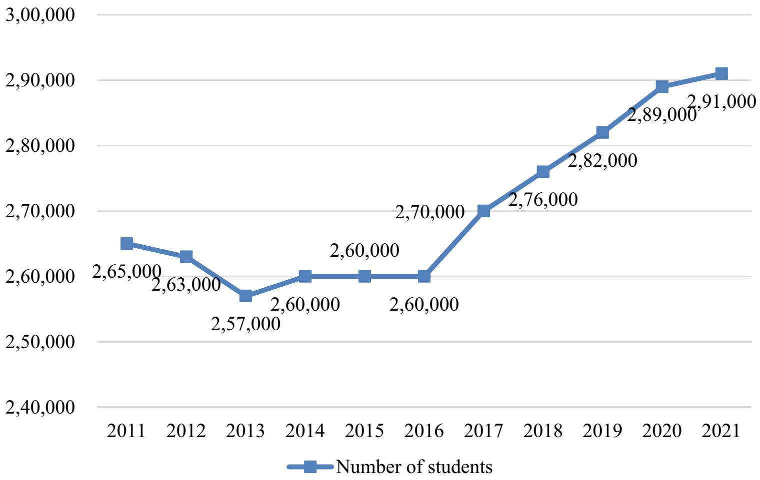

Fig. 5 Number of students (2011–2021) (in thousand). *Source* MOE (2012–2022)

was the only category that showed a downward trend. The figures for higher education gradually increased and overtook that for upper secondary education in 2019. The figures for special education and private school generally showed an upward trend.

5.1.6 Number of Full-Time Teachers

Figure 7 shows the total number of full-time teachers in all types of schools at all levels in China during the period from 2011 to 2021. The figures increased steadily during the period.

5.1.7 Number of Full-Time Teachers by Educational Sector and Level

Figure 8 shows the number of full-time teachers in schools by educational sector and level in China during the period from 2011 to 2021. The figures for all categories generally went up during the period. The number of full-time teachers of elementary school remained as the highest among all categories during the period. It is noticeable that the number of full-time teachers of preschool increased significantly and it nearly tripled from 1,316 thousand in 2011 to 3,191 thousand in 2021. The figures for higher education also increased considerably. The figures for special education remained as the lowest but consistently grow during the period.

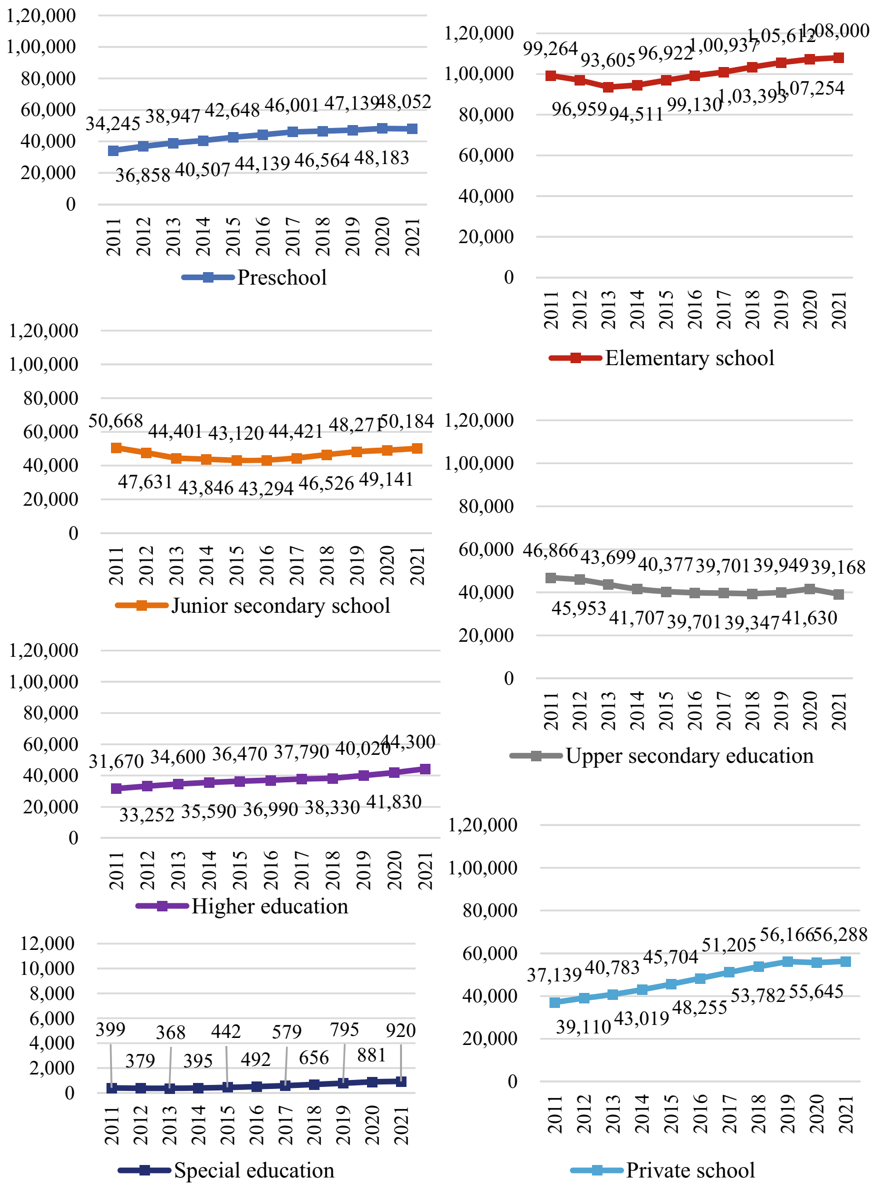

Fig. 6 Number of students by educational sector and level (2011–2021) (in thousand). *Source* MOE (2012–2022). *Notes* 1. Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. In 2021, the data of upper secondary education do not include the data of senior high schools for adults, and the data of secondary vocational school do not include the data of technical schools. 2. Private school refers to all levels of schools that are not state-run, which includes preschool, elementary school, junior secondary school, regular senior high school, secondary vocational school, and regular HEIs

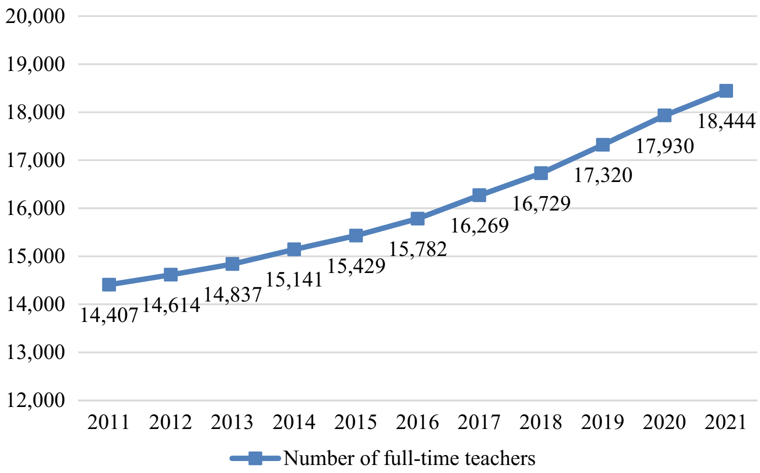

Fig. 7 Number of full-time teachers (2011–2021) (in thousand). *Source* MOE (2012–2022)

5.2 *Trends in Education Resources*

Based on *The Statistical Bulletin on Education Spending* co-released by MOE, NBS, and MOF from 2012 to 2021, this section shows the trends in education resources in China during the decade from the following four aspects: the overall spending on education nationwide, the general public expenditure on education, the general public expenditure on education per student, and the general public operating expenditure on education per student.

5.2.1 Overall Spending on Education

Figure 9 shows the trends of China's overall spending on education nationwide during the period from 2011 to 2020. The figures increased steadily during the decade, and the figure for 2020 doubled that for 2011.

5.2.2 General Public Expenditure on Education

Figure 10 shows the trend of China's general public expenditure on education during the period from 2011 to 2020. The figures increased consistently during the decade, and the figure for 2020 doubled that for 2011.

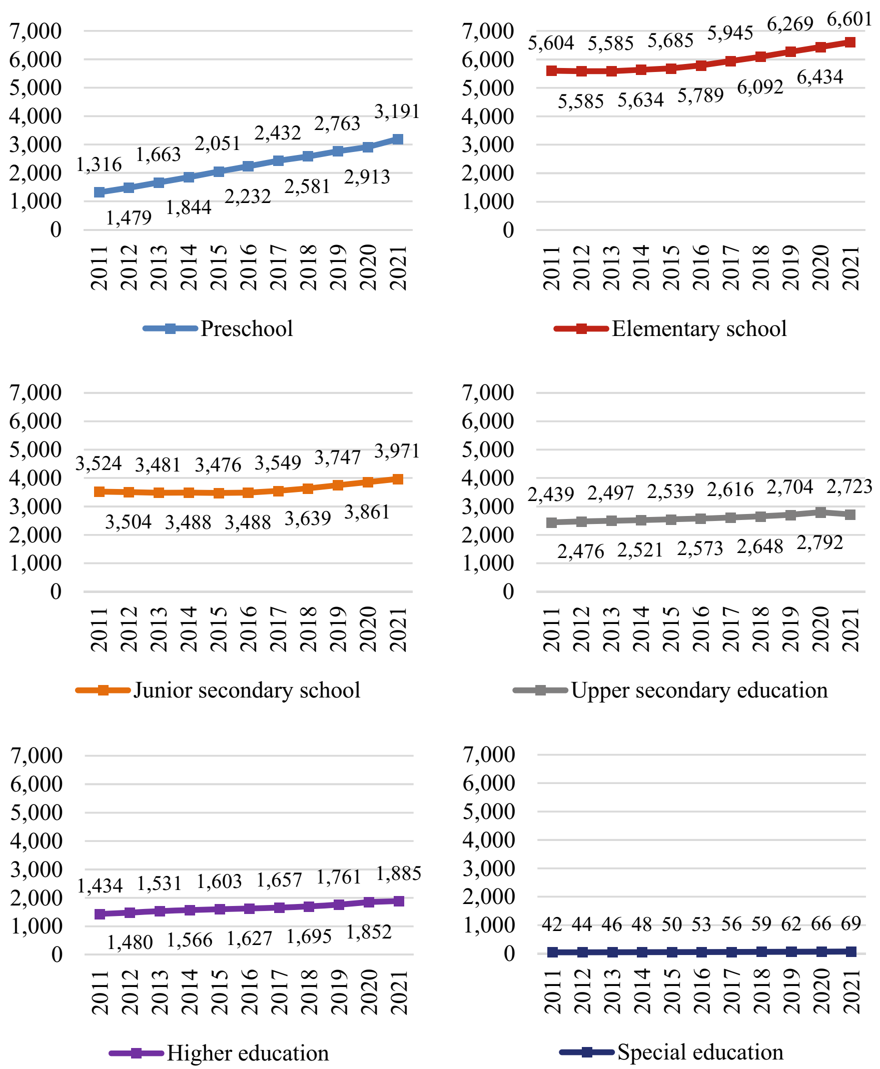

Fig. 8 Number of full-time teachers by educational sector and level (2011–2021) (in thousand). *Source* MOE (2012–2022). *Notes* Upper secondary education includes regular senior high schools, secondary vocational schools, and senior high schools for adults. In 2021, the data of upper secondary education do not include the data of senior high schools for adults, and the data of secondary vocational school do not include the data of technical schools

5.2.3 General Public Expenditure on Education Per Student

Figure 11 shows the trend of China's general public expenditure on education per student in six levels of schools during the period from 2017 to 2020. The figures for five categories (exclude higher education) increased consistently during the period.

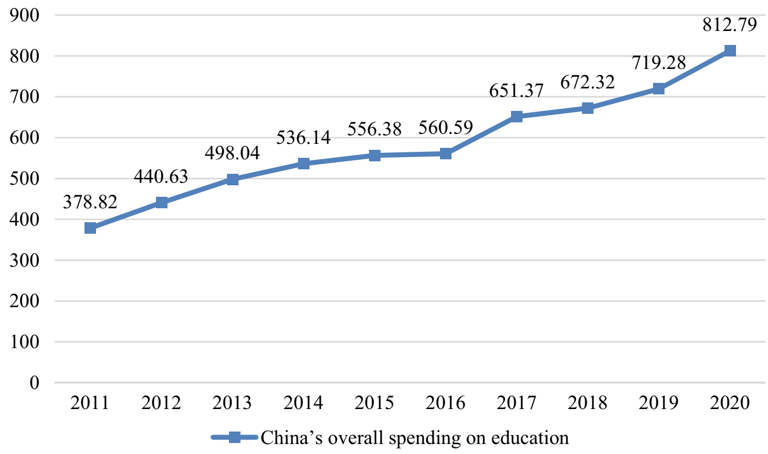

Fig. 9 China's overall spending on education (2011–2020) (in US$ billion). *Source* MOE et al. (2012–2021). *Notes* The exchange rates of the data years are used

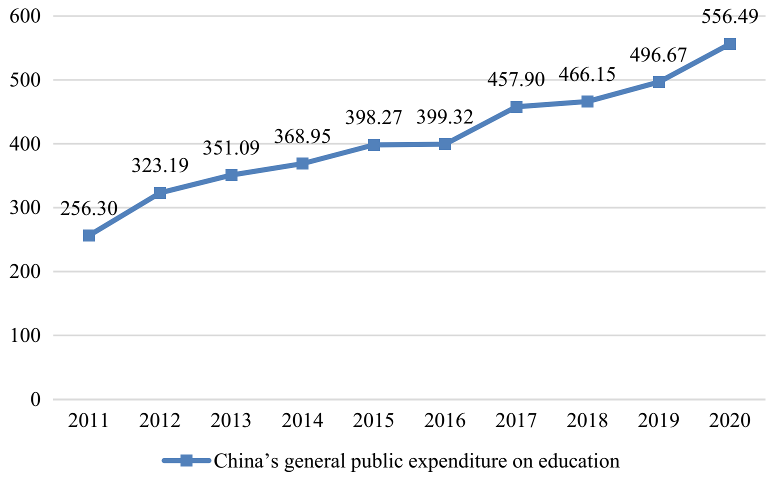

Fig. 10 China's general public expenditure on education (2011–2020) (in US$ billion). *Source* MOE et al. (2012–2021). *Notes* 1. General public expenditure on education includes operating expenditure, investments in infrastructure, and education surcharge. 2. The exchange rates of the data years are used

The figure for higher education slightly declined in 2018 and then went up again, while higher education maintained as the highest during the period. The figures for preschool continue to be the lowest.

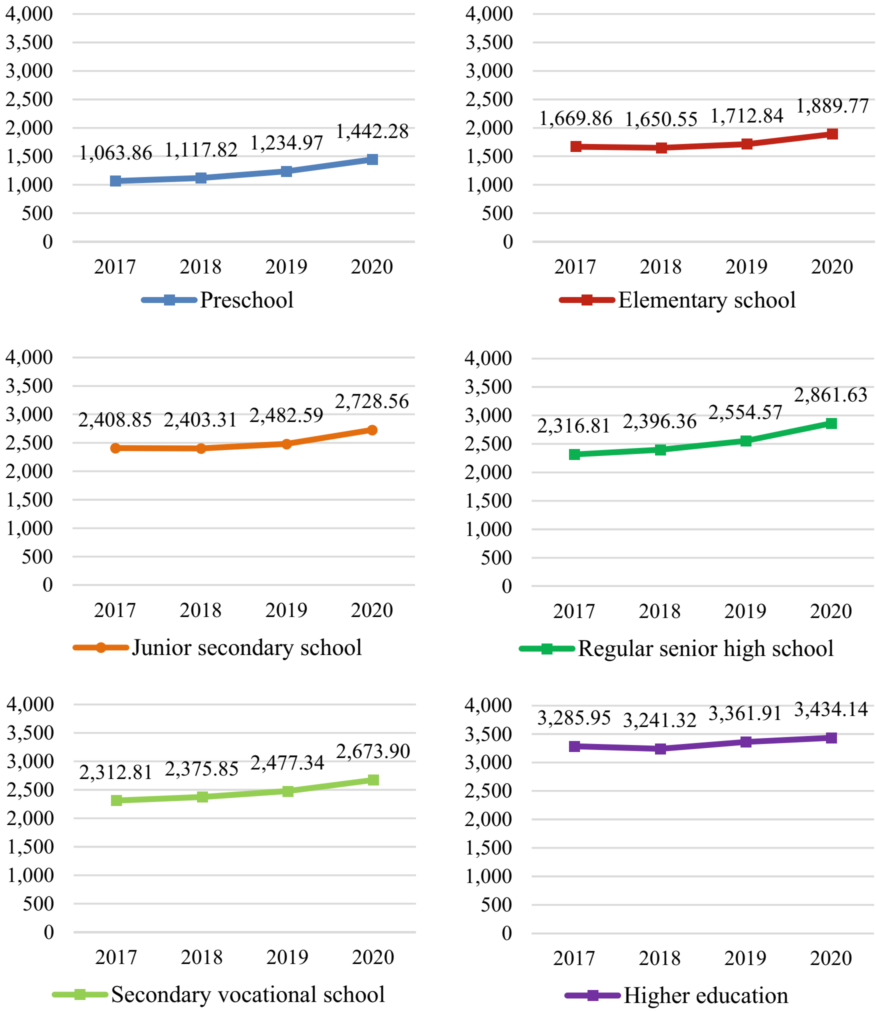

Fig. 11 General public expenditure on education per student (2017–2020) (US$). *Source*: MOE et al. (2018–2021). *Notes* The exchange rates of the data years are used

5.2.4 General Public Operating Expenditure on Education per Student

Figure 12 shows the trend of China's public operating expenditure on education per student in six levels of schools during the period from 2011 to 2020. The figures for all categories generally experienced an upward trend during the period. The figures for higher education were considerably higher than that for other categories and maintained as the highest, while the figures for elementary school were the lowest (the figures for preschool became the lowest after it was included in 2017).

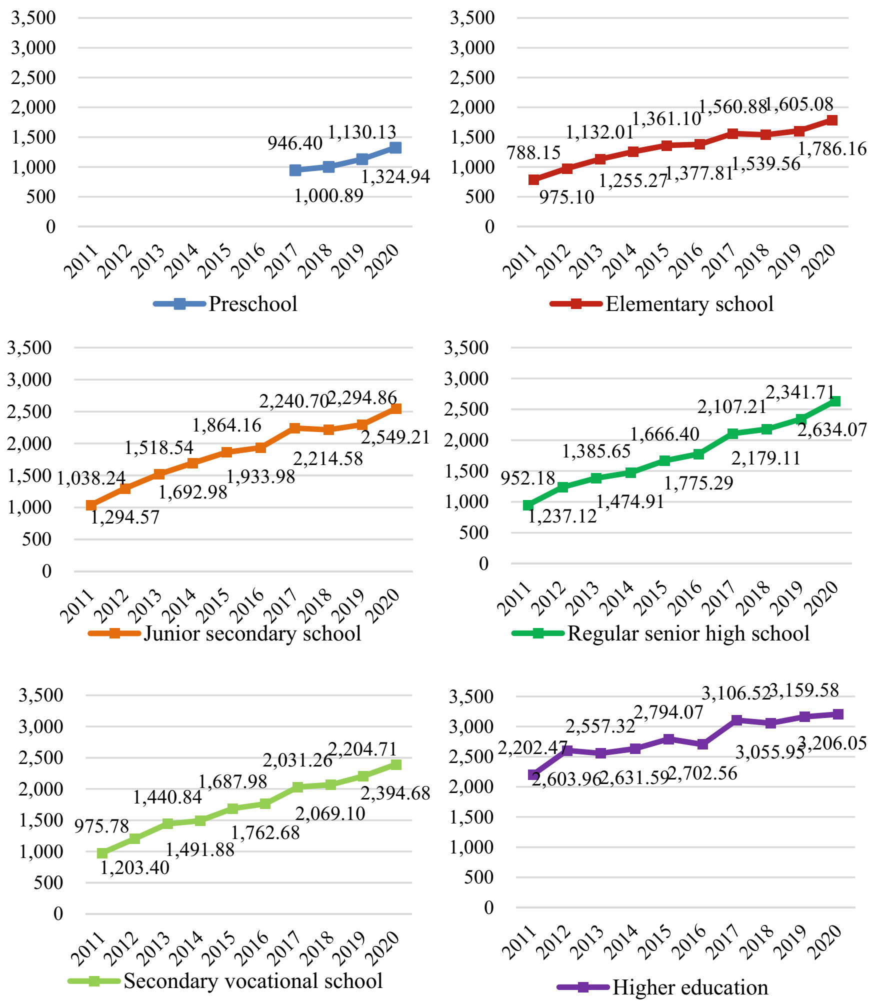

Fig. 12 General public operating expenditure on education per student (2011–2020) (US$). *Source* MOE et al. (2012–2021). *Notes* 1. The data of preschool only cover the period of 2017–2020. 2. The exchange rates of the data years are used

5.3 *Trends in HEIs' Scientific Research*

5.3.1 The S&T Achievements of China's HEIs

The achievements mainly include four categories: scientific and technological books, academic papers, international projects completed and approved, and intellectual property rights and patents.

Table 11 Number of scientific and technological achievements (2016–2021)

		2016	2017	2018	2019	2020	2021
Scientific and technological books	Total number	13,113	14,046	13,824	14,685	13,619	13,740
Academic papers	Total number	870,529	918,161	957,332	1,026,200	1,083,321	1,129,917
	Published on foreign academic journals	302,414	343,999	376,836	444,735	523,834	571,696
International projects completed and approved	Total number	4,884	4,628	3,359	3,214	2,743	3,271
Intellectual property rights and patents	Applied	184,423	229,458	266,418	310,276	330,375	328,896
	Authorized	121,981	144,375	163,157	184,934	206,036	268,450
	Sold	2,695	4,803	5,899	6,115	9,229	15,169
	Other intellectual property rights and patents	11,943	16,300	18,773	25,079	32,093	34,915

Source DSTI (2017–2022)

Table 11 and Figs. 13, 14, 15 and 16 illustrate the scientific and technological achievements of China's HEIs during the period from 2016 to 2021. The number of scientific and technological books published by China's HEIs fluctuated during the period. The figures for academic papers and intellectual property rights and patents steadily rose. The figures for international projects completed and approved have consistently declined during the period from 2016 to 2020 but rose in 2021.

5.3.2 The S&T Talents of China's HEIs

The talents mainly include three categories: teaching and scientific research personnel, R&D personnel, and personnel of scientific and technological services.

Table 12 and Fig. 17 show the scientific and technological talents of China's HEIs during the period from 2016 to 2021. The total number of talents has steadily increased during the period from 2016 to 2020, but slightly went down in 2021. The figures for teaching and scientific research personnel maintained as the highest among the three categories.

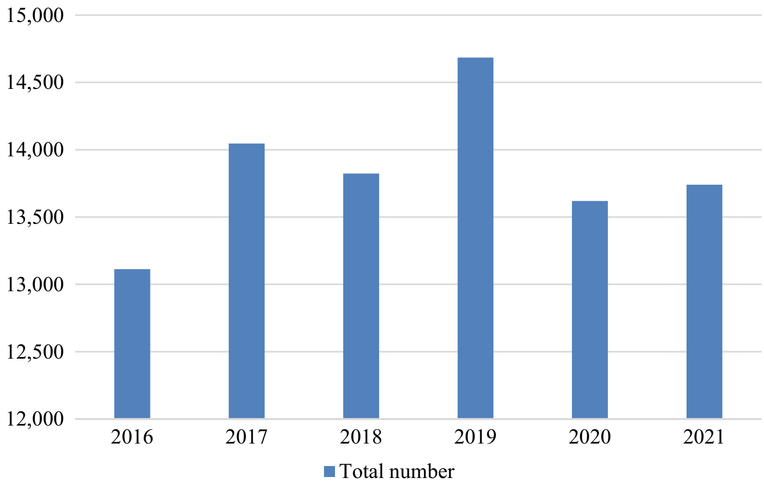

Fig. 13 Number of scientific and technological books (2016–2021). *Source* DSTI (2017–2022)

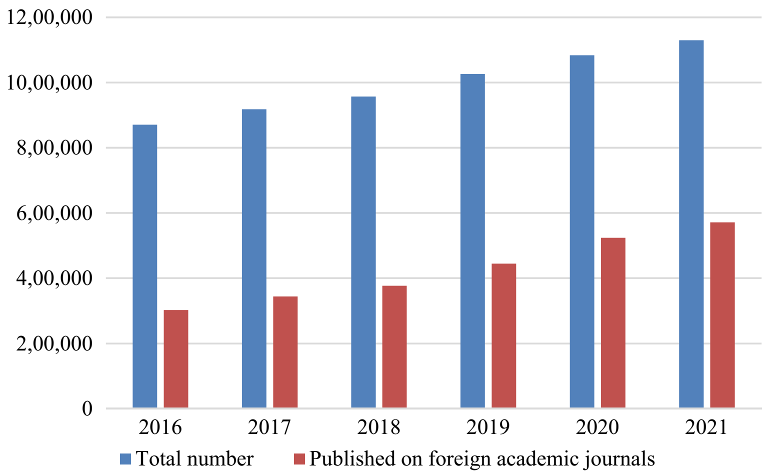

Fig. 14 Number of academic papers (2016–2021). *Source* DSTI (2017–2022)

5.3.3 The S&T Projects of China's HEIs

The projects mainly include three categories: basic research projects, applied basic research projects, and experiment and development projects.

Table 13 and Fig. 18 show the scientific and technological projects of China's HEIs during the period from 2016 to 2021. The figures for the three types of projects gradually went up, and the figures for applied basic research projects maintained as the highest.

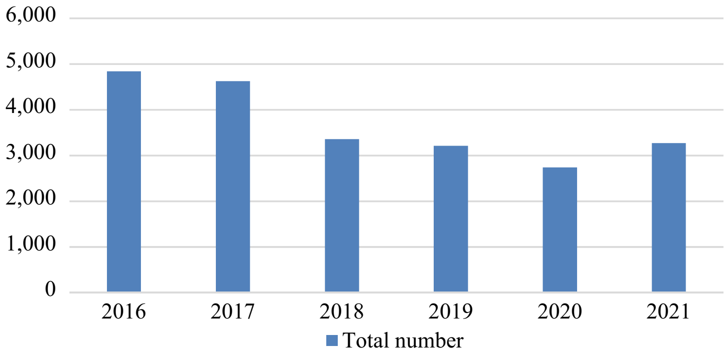

Fig. 15 Number of international projects completed and approved (2016–2021). *Source* DSTI (2017–2022)

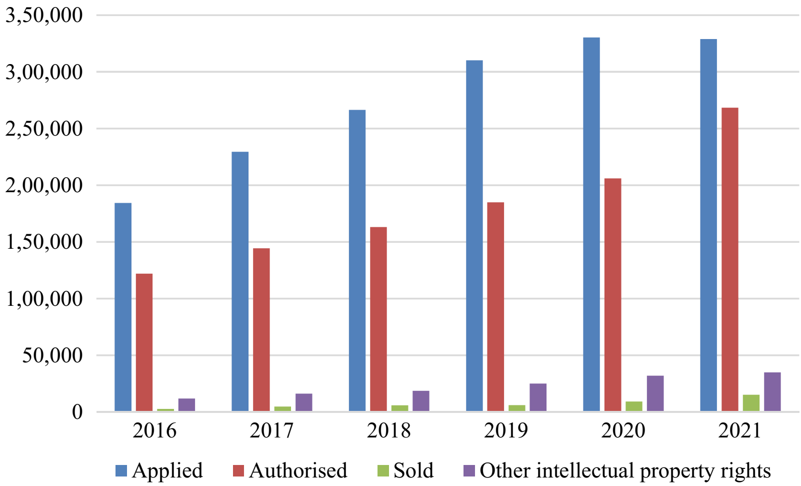

Fig. 16 Number of intellectual property rights and patents (2016–2021). *Source* DSTI (2017–2022). *Notes* "Other intellectual property rights and patents" mainly include software registration, integrated circuit design registration, new animal and plant varieties registration, and national new drug registration, etc

This section summarizes the developmental trend of education in China from 2011 to 2021. Analysis of trends in educational scale, funding resources, and scientific research at HEIs shows that education in China has undergone rapid transformation in the past decade, especially the higher education sector. In 2021, the number of students and full-time teachers in China reached the highest in history. At the same time, Chinese government's expenditure on education increased substantially, and the expenditure on higher education per student exceeded per student funding for

Table 12 Number of scientific and technological talent (2016–2021)

	2016	2017	2018	2019	2020	2021
Total number	1,403,401	1,464,580	1,555,003	1,650,157	1,910,511	1,852,109
Teaching and scientific research personnel	979,185	1,027,400	1,091,319	1,147,044	1,227,484	1,268,970
R&D personnel	381,102	391,240	414,886	445,190	606,242	516,101
Personnel of scientific and technological services	43,114	45,940	48,798	57,923	76,785	67,038

Source DSTI (2017–2022)

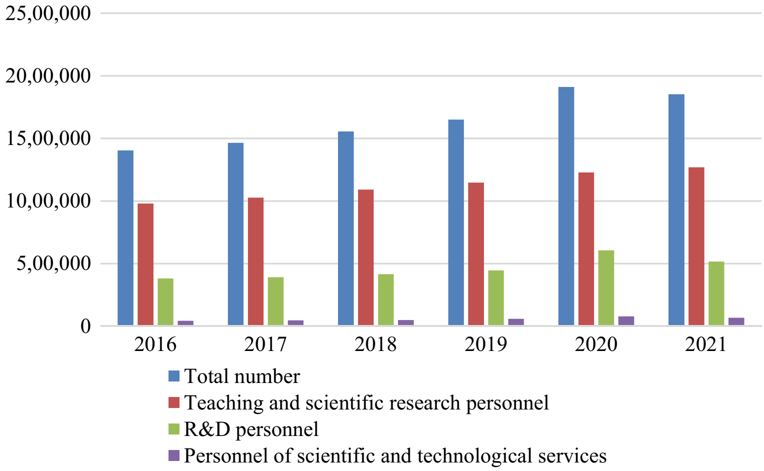

Fig. 17 Number of scientific and technological talent (2016–2021). *Source* DSTI (2017–2022)

Table 13 Number of scientific and technological projects (2016–2021)

	2016	2017	2018	2019	2020	2021
Total number	450,726	481,264	516,752	576,260	644,100	696,714
Basic research projects	195,575	210,477	230,359	254,651	286,509	303,197
Applied basic research projects	216,993	229,426	246,079	271,756	298,297	328,869
Experiment and development projects	38,158	41,361	40,314	49,853	59,294	64,648

Source DSTI (2017–2022)

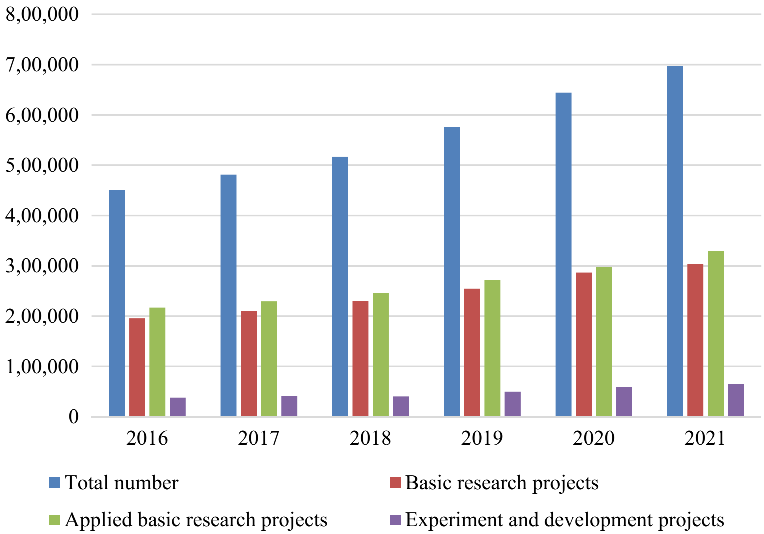

Fig. 18 Number of scientific and technological projects (2016–2021). *Source* DSTI (2017–2022)

other education levels. Chinese HEIs' S&T development has also shown significant progress, in terms of the number of academic papers and S&T projects.

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Chapter 2
Elementary Education in China

Kong Ming and Chen Jing

Abstract This chapter introduces elementary education in China, the first stage in formal education. The first part of this chapter provides an overview of elementary education in China with the situation in major developed countries presented as a reference. Then, Shanghai and California are compared to further understand excellence in elementary education, based on publicly accessible statistics retrieved from OECD, official yearbooks, and government websites. Our results demonstrate that China has been doing a remarkable job serving the highest number of children in the world and has been comparable with excellent elementary educational systems across the world with regard to total educational expenditure, gross enrollment rate, student–teacher ratio, student academic abilities, as well as the quality of educational facilities. However, it still falls behind in terms of educational expenditure per student and the composition of the highest educational degree received by teachers. The second part of this chapter further introduces elementary education in China from four aspects, including featured educational practices, stories of inspiring teachers, contemporary educational research, and critical educational policies. Examinations in this chapter suggest that policies, research, and practices go hand-in-hand in improving the quality of elementary education in China by emphasizing educational equity, morality in education, reducing student burdens, and promoting students' well-being and holistic development. In sum, elementary education in China has been and will further increase its capacity in supporting students' lifelong development and the sustainable development of the country.

Keywords Elementary education · Educational quality · Educational equity · Moral education · Reducing student burden · All-round development

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1 Introduction

1.1 The Establishment of Formal Elementary Education in China

The beginning of formal elementary education in China can be dated back to 1878 when Zhengmeng Academy (*Zhengmeng Shuyuan*) was established in Shanghai. In 1904, the government of the Qing Dynasty implemented the *Presented School Regulation* (*Zouding Xuetang Zhangcheng*) (Zhang et al., 1904), which stipulated that seven-year-old children can enroll in elementary school with curriculums including morality, Chinese language arts, arithmetic, history, geography, gymnastics, etc. After the May Fourth Movement in 1919, the Chinese writing system underwent a great change—the Ministry of Education (MOE) promoted simplified Chinese characters to replace traditional Chinese characters starting from the education in the first and second grade in elementary schools. This change has facilitated children's acquisition of reading and writing abilities and contributes to the enlightened role of elementary education.

Since the founding of the People's Republic of China, China's elementary education has become increasingly popular and, particularly has seen a robust growth since the late 1970's. In 1952, *Elementary School Teaching Plan* was issued by MOE, which was the first nationwide standard for elementary education. In 1980, the government issued the *Decision on Several Issues Concerning Popularizing Elementary Education*, elevating the popularization of elementary education nationwide and creating an unprecedented enrollment goal to be achieved in the near future (The State Council, 1980). In 1985, the *Decision on the Reform of the Educational Structure* was issued (Central Committee of the CPC, 1985). This was the first time that the nine-year compulsory education was proposed, which aimed to increase opportunities for enrollment in elementary education. In 1986, elementary education became compulsory, safeguarded by the *Compulsory Education Law of the People's Republic of China*. Since then, elementary education has been both a right and obligation of every citizen in this country. In 1993, the government promulgated the *Program for Educational Reform and Development in China*, which emphasized the importance of elementary education for the development of individuals and that of the country (The State Council, 1993).

1.2 Contemporary Elementary Education in China

During the twenty-first century, research on elementary education in China has flourished driven by national needs. In 2001, the New Curriculum Reform was implemented, which encourages in-depth studies on restructuring curriculum, creating evaluation standards, and establishing educational management system. In 2016, the State Council issued *Several Guidelines on Comprehensively Promoting Reform and*

Development to Integrate Urban and Rural Compulsory Education within County Areas, which targets the problem of educational inequality between rural and urban areas (The State Council, 2016). In 2019, the government issued *Guidelines on Deepening the Reform of Education and Teaching and Comprehensively Improving the Quality of Compulsory Education*, which actively responded to issues that have raised great concern in the society, such as elementary school enrollment, reducing student burdens, and teachers' right to discipline students when necessary (The State Council, 2019). Further, it emphasized the need to strengthen family education and home-school ties, so as to collaboratively create a collaborative educational ecology. In 2022, MOE released the *Curriculum Program and Curriculum Standards of Compulsory Education* (MOE, 2022), which updates the content and goals of instructions in elementary schools, strengthening support and guidance for online learning in response to the outbreak of COVID-19.

Nowadays, elementary education in China is free and compulsory for all children who reach six years old, and universal access to compulsory education in China has been achieved since 2011. As a result, elementary education in China serves the largest number of students in the world. With continuous efforts from government and society, the quality of elementary education is advancing as indicated by growing educational expenditure, increasing gross enrollment rate, high-quality teacher professional development, guaranteed educational facilities in the vast majority of elementary schools, and outstanding student outcomes, such as the high completion rate, extraordinary academic abilities, as well as all-round competence in lifelong learning.

A considerable number of outstanding schools have emerged in China as a result of continuous innovation in the new era. Schools have continuously explored new education modes, emphasizing students' well-rounded development and teachers' morality and competencies in teaching. Meanwhile, research on elementary education in China is no longer confined to instructional strategies in certain subject domains but has been extended to a wider range of topics, including all-round development, education equity, and individualized development. China has also been refining educational policies so as to better guide the development of practices in elementary education.

Elementary education in China is now standing at a new historical moment-after solving the problem of accessing elementary education, providing high-quality elementary education to all people in the country is the next major challenge. First, from the perspective of educational equity, beyond offering fair opportunities in enrollment, elementary education in China is working on providing fair and high-quality educational resources during the process of education. Particularly, regarding the quality of elementary education across regions, there is still a significant gap across the eastern, central and western regions, between urban and rural areas, and even between districts within the same cities in China. Second, teachers and parents do not always share the same educational beliefs and work closely with each other. It is still prevalent among parents who urge their children to pursue high testing scores and high educational degrees without supporting their children in fully exploring personal interest and advantages. Third, although educational technology can facilitate the sharing of high-quality educational resources, the integration of technology and elementary education is far from enough. On the one hand, technologies should be designed by using evidence-based research and seek to meet specific educational needs. On the other hand, teachers and students may need better training in implementing novel technologies. It is clear that elementary education in China has taken many steps forward, yet there may still be a long way to providing excellent elementary education for every citizen in China. What shall we expect in the near future? The Chinese MOE has been committed to the realization of high-quality and balanced elementary education by 2035.

The following sections of this chapter starts with an overview of China's elementary education and its development. It then takes Shanghai as a case study to compare its elementary education with that of California state in the U.S. The chapter provides analysis on the best practice of elementary schools in China, and shares inspiring stories on three outstanding educators in the Chinese elementary education sector who aim to deliver educational philosophies through their daily work. This chapter also reviews the latest research trends and the national policies significantly shaping elementary education in China.

2 Highlighting Data

2.1 Duration and Scale of Elementary Education

The duration of elementary education in China typically is six years with a few exceptions, such as in Shanghai for five years which is further discussed in section three in this chapter. Based upon 2019 statistics from UNESCO Institutes for Statistics (UIS), the scale of the Chinese elementary education is significantly larger than other major countries including the United States (U.S.), the United Kingdom (U.K.), Germany, France, the Netherlands, Japan, and the Republic of Korea (ROK) (Figs. 1, 2). The numbers of teachers and enrolled students at Chinese elementary schools reached 6,526,772 and 106,250,528 respectively in 2020.

2.2 Gender Proportions Among Teachers in Elementary Education

Among teachers, about 70% of them are female, which is lower than other major developed countries (Fig. 3). This suggests a relatively more balanced gender distribution among elementary school teachers in China.

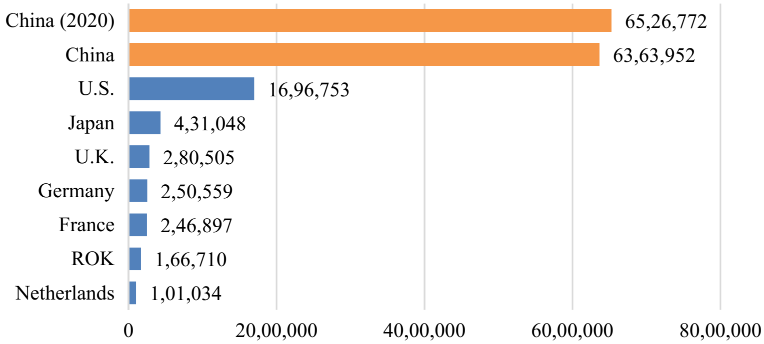

Fig. 1 Number of teachers in elementary education (2019). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

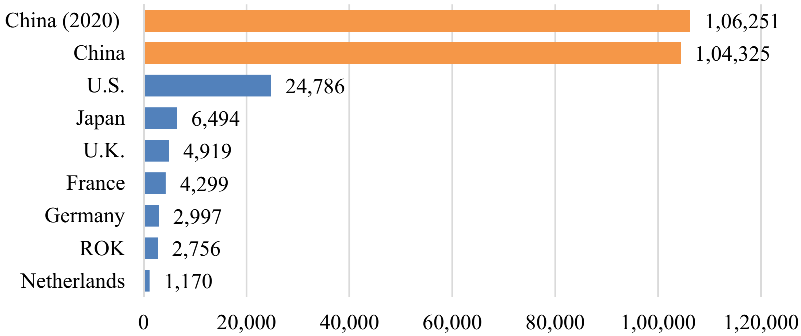

Fig. 2 Number of enrolled students in elementary education (in thousands) (2019). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

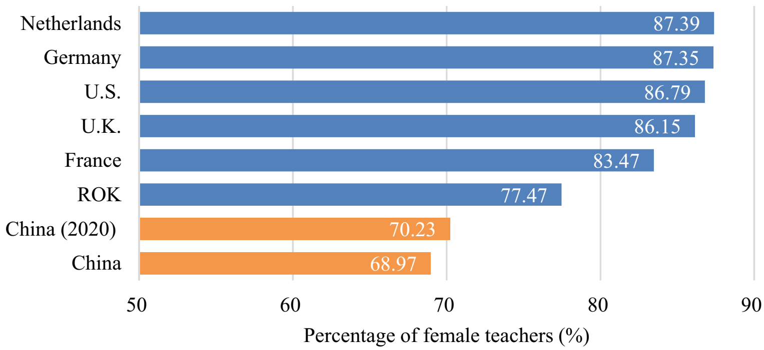

Fig. 3 Percentage of teachers in elementary education who are female (2019) (%). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

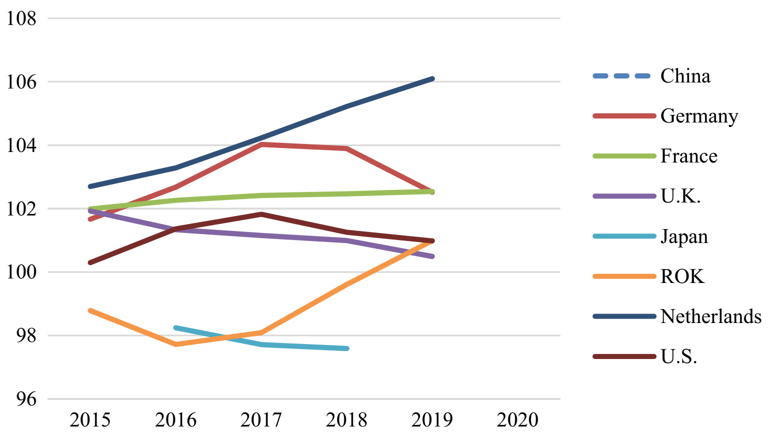

Fig. 4 Gross enrollment ratio in elementary schools (2015–2020) (%). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

2.3 Gross Enrollment Ratio of Elementary Education

The gross enrollment ratio refers to the number of students enrolled in each level of education, regardless of age, which is demonstrated as a percentage of the official school-age population corresponding to the same level of education based on the definition provided by UIS. In China, the gross enrollment ratio for elementary education has been growing in recent years. It reached 102% in 2019 and 103% in 2020, which is comparable with, if not higher than, other major developed countries (Fig. 4). The gross enrollment rate by gender is presented in Fig. 5, which favors girls slightly better than boys in China, with both rates being comparable with other major developed countries.

2.4 The Proportion of Enrollment in Public Institutions

UIS differentiates public and private educational institutions by whether they are operated by a public authority or controlled and managed by a private body (e.g., non-governmental organization, religious body, special interest group, foundation, or business enterprise). In China, among students enrolled in elementary education, more than 90% were enrolled in public (as opposed to private) educational institutions. This proportion has been stable in the past few years (Fig. 6) and is comparable with major developed countries (Fig. 7). Thus, the statistics reported in this chapter focus primarily on public schools in elementary education.

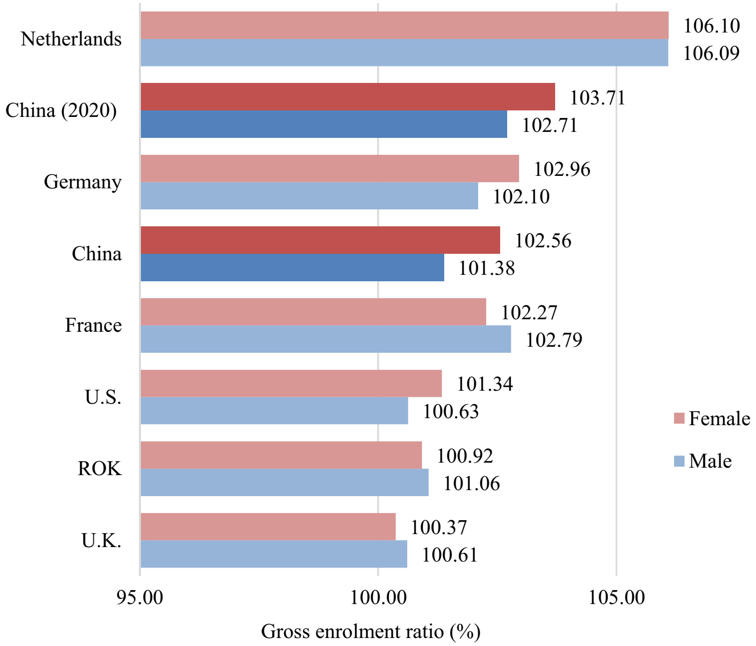

Fig. 5 Gross enrollment ratio by gender in elementary schools (2019) (%). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

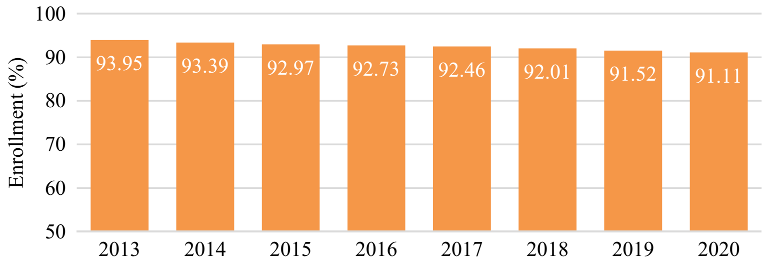

Fig. 6 Proportion of enrollment in public institutions in China (2013–2020) (%). *Source* UIS (2022)

2.5 Government Expenditure on Elementary Education

Government expenditure on elementary education refers to the total general (local, regional and central) government expenditure on elementary education based on the definition from UIS. In China, the governmental expenditure on elementary education was Chinese yuan (RMB) 1,379,291 million in 2019 (Ministry of Finance, 2020), which was equivalent to **US$**327,776 million in purchasing power parity dollars (PPP$) or 1.40% of the GDP of the country in 2019 (National Bureau of

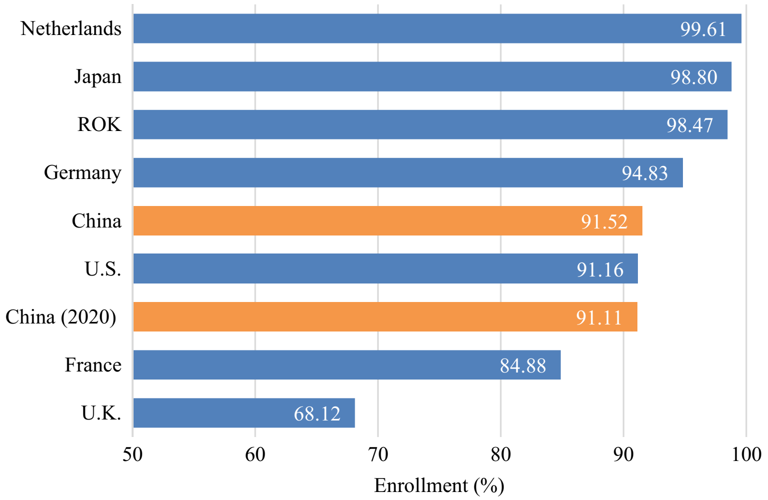

Fig. 7 Proportion of enrollment in public institutions (2019) (%). *Source* UIS (2022). *Notes* The latest available information for most countries is 2019, although 2020 data have been available for China. Thus, the information for China in these two years are presented

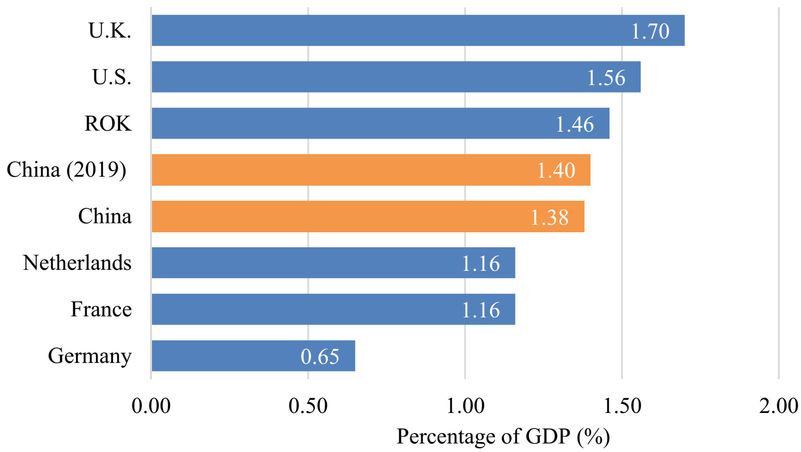

Fig. 8 Government expenditure on elementary education as a percentage of GDP (2018) (%). *Source* UIS (2022); Ministry of Finance (2020); National Bureau of Statistics (2021a). *Notes* The latest data for all countries except that of China were retrieved from UNESCO, where the latest available information is for 2018. The data for China were missing in the UNESCO database, so the data were manually calculated based on the *China Educational Finance Statistical Yearbook* (Ministry of Finance, 2020) and the *China Statistical Yearbook* (Ministry of Finance, 2021a)

Statistics, 2021a). For comparisons with other major developed countries, please see Figs. 8 and 9 based on the latest information retrieved from the UIS database.

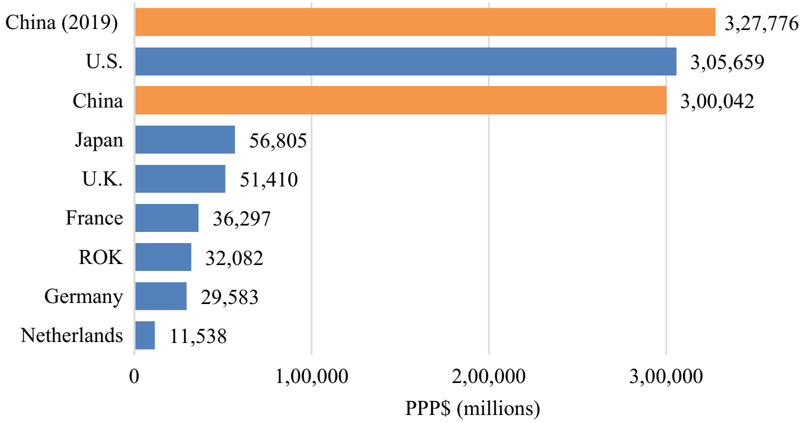

Fig. 9 Government expenditure on elementary education in PPP$ (2018). *Source* UIS (2022); Ministry of Finance (2020); National Bureau of Statistics (2021a); OECD (2022a). *Notes* The latest data for all countries retrieved from UNESCO was for 2018. The data for China was not available in UNESCO database, which was manually calculated based on the *China Educational Finance Statistical Yearbook* (Ministry of Finance, 2020) and the *China Statistical Yearbook* (National Bureau of Statistics, 2021a). The data for 2018 are for the purpose of comparison with the other countries, and the data for 2019 are the latest available

2.6 Government Funding Per Elementary Student

The above total amount of government expenditure may not provide the whole picture, as the elementary education system in China serves a large number of populations. The initial government funding per elementary student in China was calculated based on the total expenditure in elementary education retrieved from the *China Educational Finance Statistical Yearbook* (Ministry of Finance, 2020) and the total enrollment in elementary school retrieved from the *China Statistical Yearbook* (National Bureau of Statistics, 2021a). As presented in Fig. 10 and Fig. 11, government funding per elementary student has been growing in China in recent years, although it is still far from comparable with other major developed countries.

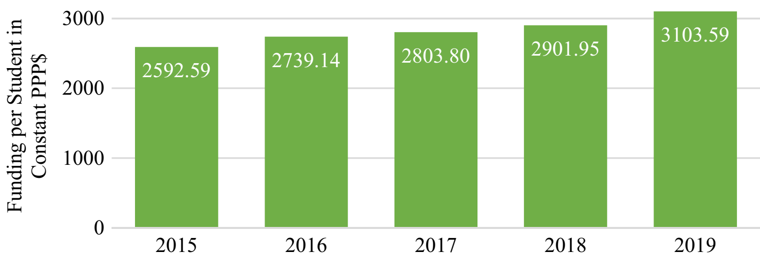

Fig. 10 Initial government funding per elementary student in constant PPP$ in China (2015–2019). *Source* Ministry of Finance (2020); National Bureau of Statistics (2021a); OECD (2022a)

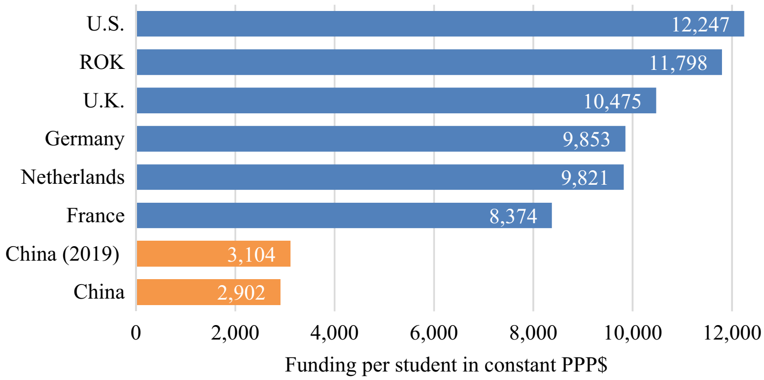

Fig. 11 Initial government funding per elementary student in constant PPP$ (2018). *Source* UIS (2022); Ministry of Finance (2020); National Bureau of Statistics (2021a); OECD (2022a). *Notes* The latest data for all countries were retrieved from UNESCO for 2018, except that the data for China were missing in the database. The latest data for China were calculated by dividing the amount of government funding for elementary schools (Ministry of Finance, 2020) by the number of enrolled elementary school students for the corresponding years (National Bureau of Statistics, 2021a). The RMB was transformed into PPP$ based on the conversion rate for the specific year reported by OECD (2022a)

2.7 Basic Facilities in Elementary Schools

The proportion of elementary schools with basic facilities has been rising in recent years in China. As of 2020, 99% elementary schools have the access to basic drinking water, handwashing facilities, single-sex basic sanitation facilities, and electricity; more than 98% elementary schools have the access to computers and the internet for pedagogical purposes (Fig. 12).

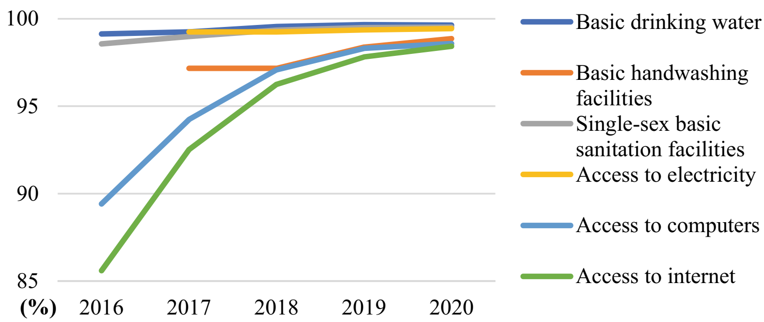

Fig. 12 Proportion of elementary schools with basic facilities in China (2016–2020) (%). *Source* UIS (2022)

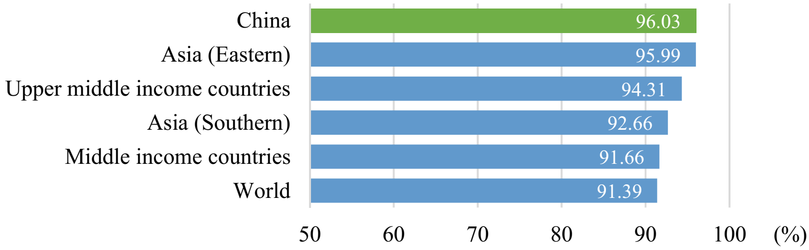

Fig. 13 Percentage of qualified teachers in elementary education (2020) (%). *Source* UIS (2022)

2.8 Qualified Teachers

Qualified teachers refer to teachers who have at least the minimum academic qualifications required for teaching their subjects at the relevant level in a country, in an academic year. In China, the percentage of qualified teachers in elementary education has remained stable at 96% for the past few years (2015–2020) based on the data released by the UIS. Although major developed countries mentioned in the prior indicators are not available through the UIS database, the percentage for China is higher than most countries (Fig. 13).

2.9 Student–Teacher Ratio and Class Size

Student–teacher ratio refers to the average number of students per teacher, while average class size is the average number of students in a classroom. These two indicators represent the amount of teacher resources individual students could receive in classrooms. Based on the latest available information released by UIS, the average student–teacher ratio for elementary education in China was about 16 (Fig. 14), and the average class size was 37 (Fig. 15). These two indicators suggest that although the total amount of educational resources is considerable in China in comparison with the world, educational resources per student falls relatively behind many developed countries.

2.10 Teacher Attrition Rate

The teacher attrition rate refers to the percentage of teachers at a level of education leaving the profession in a school year based on the definition from UIS. In China, the overall teacher attrition rate for elementary education was 4.76% in 2020, which is at a middle-to-low level compared to many other countries or regions in the world (Fig. 16). However, although the attrition rate for female teachers is low, the rate

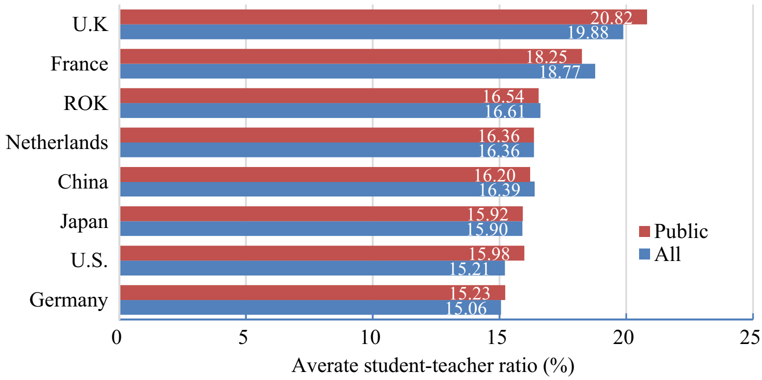

Fig. 14 Average student–teacher ratio in elementary education (2019) (%). *Source* UIS (2022)

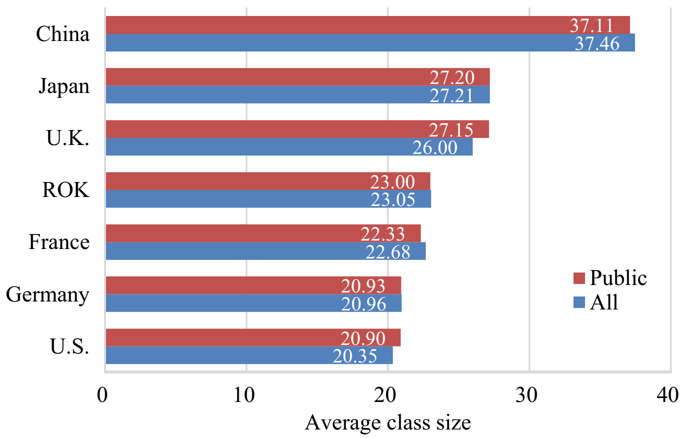

Fig. 15 Average class size in China and the world. *Source* UIS (2022). Notes: The latest available information for most countries is 2019, while for China was 2014. For the countries with available data for 2019, the class size is comparable with that in 2014

for male teachers is relatively high when compared to other regions in the world (Fig. 17). Note, the information for developed countries mentioned in other figures was missing for the current indicator in the UIS dataset, therefore, the values for various regions are reported here.

2.11 Elementary Education Completion Rate

Defined by UIS, the completion rate for elementary education refers to the percentage of a cohort of children or young people aged three to five years above the intended

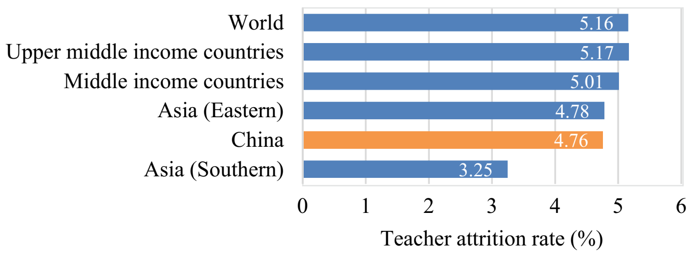

Fig. 16 Teacher attrition rate from elementary education (2020) (%). *Source* UIS (2022)

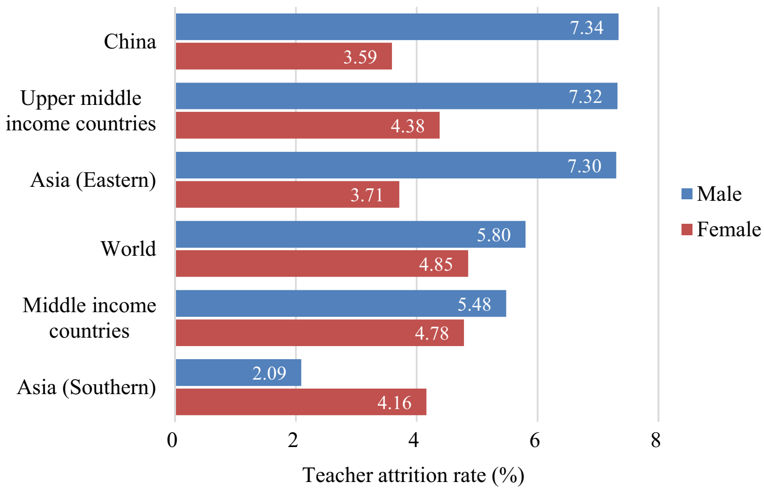

Fig. 17 Teacher attrition rate from elementary education by gender (2020) (%). *Source* UIS (2022)

age for the last grade of elementary education who have completed that grade. In China, the overall completion rate for elementary education was 95.60% in 2020, which has slightly increased from 94.60% in 2015. Also, girls consistently have a higher completion rate than boys (Fig. 18).

2.12 Second and Third Graders Achieving at Least a Minimum Proficiency in Math and Reading

UIS refers to the minimum proficiency level in math and reading as the benchmark of basic knowledge in math or reading measured through standardized tests conducted and certified by OECD. Based on the latest data available in the UIS dataset, the proportion of students in Grade 2 or 3 achieving at least a minimum proficiency level in math was 84.60% in China, which was higher than that in many developed countries

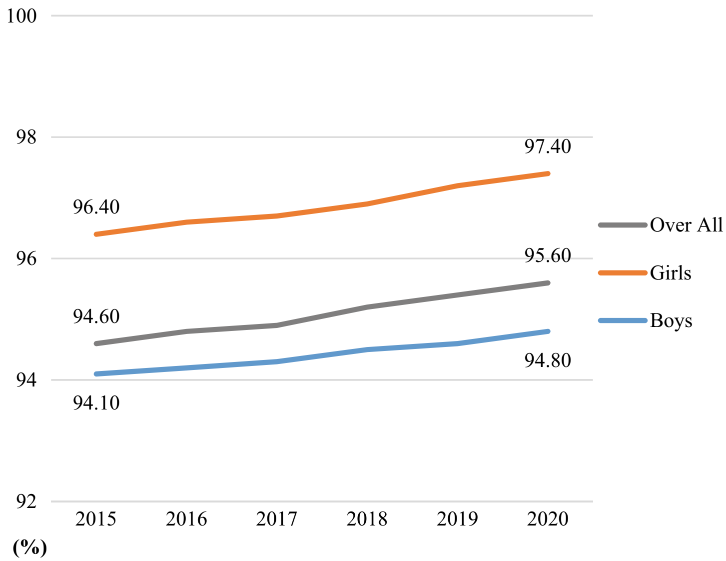

Fig. 18 Elementary education completion rate in China (2015–2020) (%). *Source* UIS (2022)

(Fig. 19). However, the proportion in reading was behind many developed countries (Fig. 20), which might relate to differences in metalinguistic skills needed in alphabetic and non-alphabetic writing systems. For instance, researchers have suggested that comprehending alphabetic languages in text relies more on readers' phonological awareness, while comprehending Chinese in text relies more on readers' morphological awareness, which is believed to be more difficult for young children (e.g., Kuo & Anderson, 2006).

2.13 Survival Rate to Grade 4

UIS describes the survival rate to Grade 4 as the percentage of a cohort of students enrolled in the first grade of elementary education in a school year who are expected to reach fourth grade, regardless of repetition. Based on the latest information, the survival rate to Grade 4 of elementary education in China was 99.92% in 2019, which is at a middle-to-high range when compared to many other countries in the world (Fig. 21).

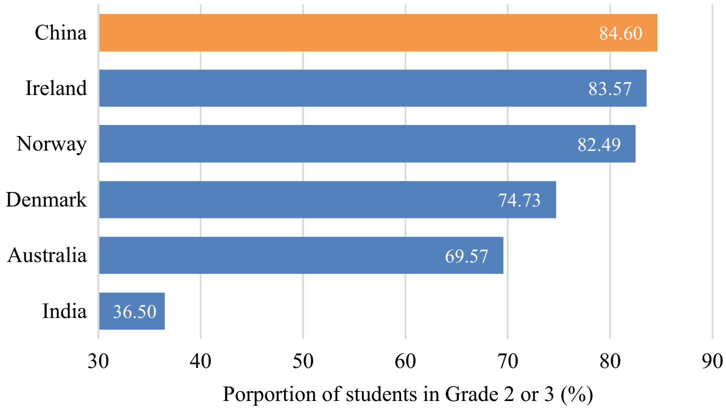

Fig. 19 Proportion of students in Grade 2 or 3 achieving at least a minimum proficiency level in math (%). *Source* UIS (2022). *Notes* The latest available data for most countries in this figure are 2019, while for China was 2015 and for India are 2017

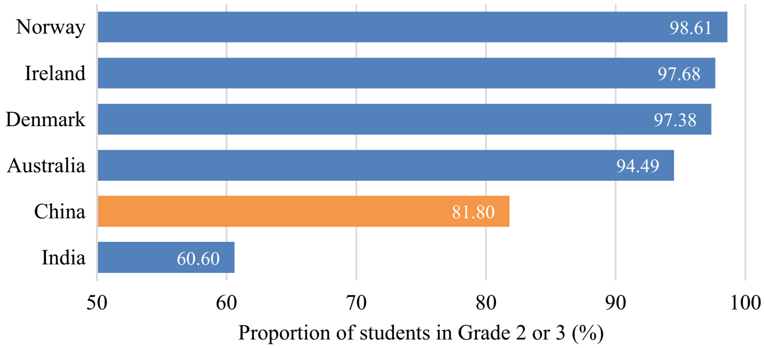

Fig. 20 Proportion of students in Grade 2 or 3 achieving at least a minimum proficiency level in reading (%). *Source* UIS (2022). *Notes* The latest data for most countries in this figure are 2016, while for India are 2017

3 Excellence Indicators

To demonstrate excellence in elementary education, this section compares one of the most developed regions in China (Shanghai) and that in the U.S. (the state of California). The duration of elementary education in Shanghai is five years, which is the same as the typical situation in California.

As shown in Fig. 22, the scale of elementary education in Shanghai is about one-third of that in California with regard to the number of students and full-time teachers. Based on the latest publicly available information, elementary education in Shanghai included 826,347 students and 59,451 full-time teachers dedicated to teaching and instruction in 2019. Elementary education in California, on the other

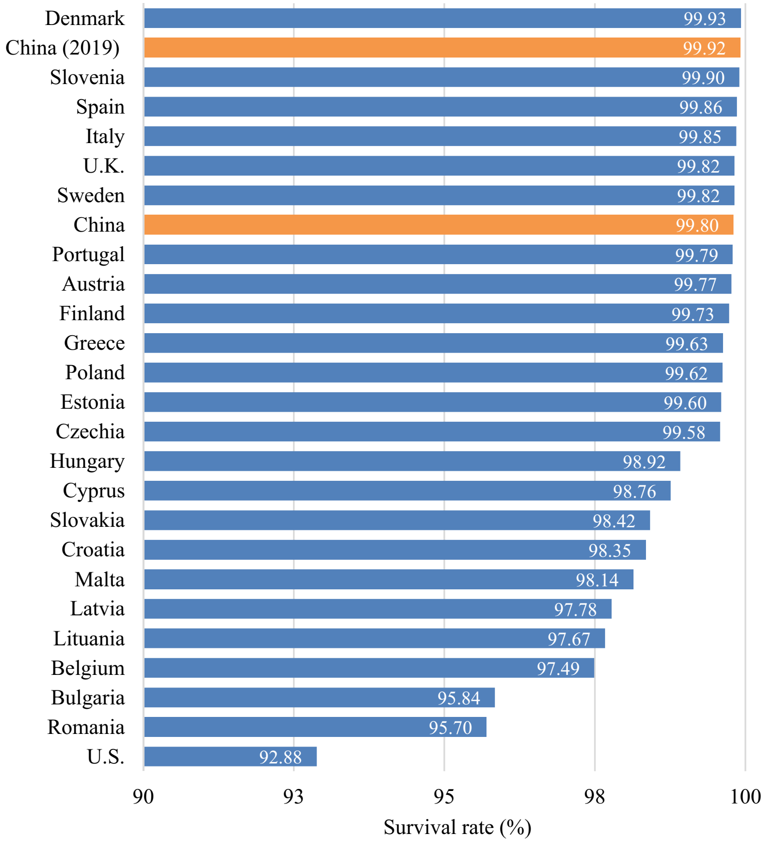

Fig. 21 Survival rate to Grade 4 of elementary education (2018) (%). *Source* UIS (2022). *Notes* The information for many developed countries mentioned above is not available in the UNESCO database, and, therefore, OECD countries are presented instead. The latest available information for most countries is 2018, although 2019 data have been available for China. Thus, the information for China in these two years are presented

hand, included 2,270,364 students from Grade 1 to Grade 5 and 154,504 teachers with full-time equivalent teaching duties.

3.1 Design

Indicators that are selected for comparison reflect excellence in elementary education across three primary aspects: educational resources, teacher quality, and student outcome. Besides conceptual reasoning, the selection of indicators is constrained by two additional criteria to allow for transparent and replicable comparisons. First, the indicators should come from publicly accessible databases and yearbooks. Second,

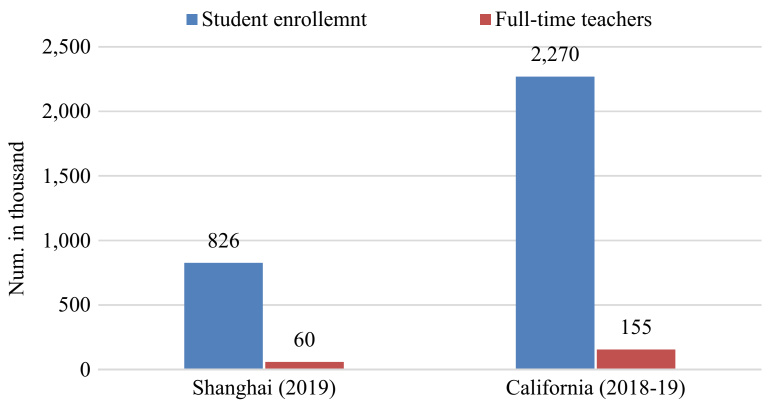

Fig. 22 The scale of elementary education in Shanghai and California. *Source* Shanghai Municipal Education Commission (2021); California Department of Education (2022)

for each indicator, the statistic found for Shanghai and that for California should be calculated in a similar (if not identical) way based upon operational definitions released by public databases and yearbooks as detailed in the following section.

Eventually, four indicators are identified for the comparison between Shanghai and California regarding excellence in elementary education: public expenditure on education (per student and in relation with other educational stage during K-12), student–teacher ratio, highest level of education received by full-time teachers, and education completion rate.

3.2 Definitions and Sources

3.2.1 Definitions

Definitions of the selected indicators to demonstrate excellent elementary education are summarized in Table 1 and are elaborated in the paragraphs below.

Public Expenditure on Education. This indicator represents societal resources invested in education, which is essential for maintaining and developing high-quality education. To make it comparable between regions with different population scales, this section focuses on two sub-indicators. One sub-indicator is the public expenditure per student at the elementary education level, which is defined as the total public expenditure on elementary education dividing the total number of students enrolled in elementary schools based on a certain year. For this indicator, RMB is transformed into PPP$ for the specific year to make the value comparable between Shanghai and California. Second, to understand public expenditure on elementary education in relation to other educational stages during K-12, the proportion of expenditure on elementary education in the total expenditure on regular K-12 education is examined,

Table 1 Operational definitions of excellence indicators

Excellence indicators	Definitions
1. Public expenditure on elementary education	Public expenditure per student: The total public expenditure on elementary education dividing the total number of student enrollment Public expenditure on elementary education in relation to other K-12 educational stages: The proportion of the total public expenditure on elementary education in the total public expenditure on the entire regular K-12 education
2. Student–teacher ratio	Student enrollment over the total number of full-time teachers
3. The highest level of educational degree received by teachers	The proportion of teachers whose highest level of educational degree is postgraduate degrees, bachelor's degree, associate degree, and high school diploma respectively
4. The elementary education completion rate	The percentage of individuals who completed elementary school among: • Students who are 3–5 years above the elementary school graduation age • Young people who are 15–24 years old

which is operationalized as the proportion of the total amount of public expenditure on elementary education in the total amount of public expenditure on the entire regular K-12 education.

Student–Teacher Ratio. This indicator has consistently been cited as an essential indicator associated with student achievement and learning experiences, especially for early school grades (e.g., Cuseo, 2007; Graue et al., 2007). The student–teacher ratio is typically operationalized as dividing the total number of students enrolled in elementary schools by the total number of full-time teachers.

The Highest Level of Educational Degree Received by Teachers. This indicator is critical in pre-service training, which has long been believed as a contributor to educational quality (for review, please see Darling-Hammond, 2000). Based on the information available from the *Educational Statistics Yearbooks of China* and the website of the California Department of Education, the highest level of education for full-time elementary school teachers can be categorized into four levels: postgraduate degrees, bachelor's degree, associate degree and high school diploma.

The Elementary Education Completion Rate. This indicator shows the outcome of elementary education. Student outcomes in learning and development reflect educational quality. However, at the stage of elementary education, there is a lack of standardized tests to support comparison at the school, region, or country level. Therefore, the elementary education completion rate reported in the World Inequality Dataset (OECD, 2022b) is selected, which defines two completion rate indices: the percentage of individuals who completed elementary school among children who are three-five years above the elementary school graduation age and young people who are 15–24 year-olds.

3.2.2 Sources

Data and information reported in this section were retrieved from or calculated based on publicly accessible databases and yearbooks. Specifically, the data for Shanghai are mainly found in various yearbooks, including *Shanghai Educational Yearbook* (Shanghai Municipal Education Commission, 2021), *China Social Statistical Yearbook* (National Bureau of Statistics, 2017, 2018, 2019, 2020, 2021b) and *Educational Statistics Yearbook of China* (MOE, 2019, 2020a, 2021a).[1] The data for California are mainly retrieved from rich statistics and datasets on the website of the California Department of Education (2022). An additional indicator is found in the World Inequality Dataset (OECD, 2022b).

Note, when it comes to financial indicators, where RMB needs to be converted to PPP$, the conversion rate for a specific year is found in the OECD report (OECD, 2022a).

3.3 Findings

3.3.1 Public Expenditure on Elementary Education

Regarding the public expenditure per student, in Shanghai, "per student general public budget expenditure on education" for regular elementary school is identified as RMB30,765.87 in the year 2020 based on the *China Social Statistical Yearbook* (National Bureau of Statistics, 2021b), equivalent to 7,350 PPP$. For California, it is reported that the "current expense per average daily attendance" for elementary education was US$12,647.80 in the 2019–2020 academic year and was US$13,215.90 in the 2020–2021 academic year (California Department of Education, 2022). The above statistics for Shanghai and California for the recent years are presented in Fig. 23, where the PPP conversion rate is based on each of the specific years as reported by OECD. It shows that Shanghai is significantly behind California regarding expenditures on elementary education per student, although it has been growing in recent years.

To further understand the above gap between Shanghai and California, the proportion of expenditure on elementary education in the total expenditure for the entire regular K-12 education is calculated. For Shanghai, the amount of "public expenditure on education" is identified by education levels in the *China Social Statistical Yearbook* (National Bureau of Statistics, 2018, 2019, 2020, 2021b). The proportion

[1] These yearbooks can be found at https://www.yearbookchina.com.

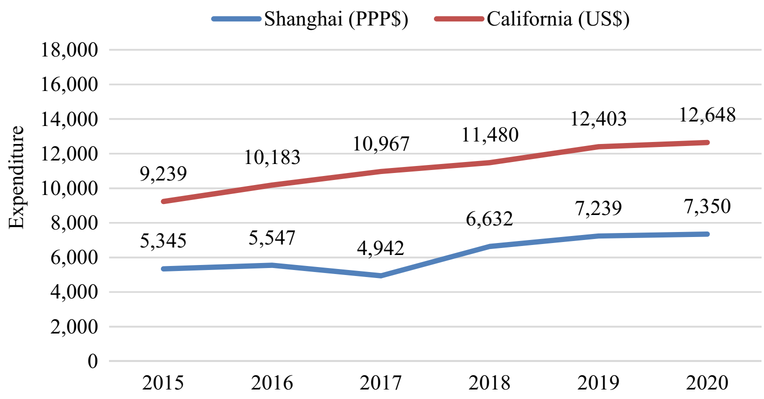

Fig. 23 Expenditure on elementary education per student in Shanghai and California. *Source* National Bureau of Statistics (2017, 2018, 2019, 2020, 2021b); California Department of Education (2022)

is calculated by dividing the expenditure on elementary education by the total expenditure from kindergarten through regular senior secondary schools. For California, the current expense for each category of K-12 "local educational agencies" is found on the website of the California Department of Education. The proportion of expenditure on elementary education is calculated by dividing the amount of expense for "elementary" schools by the total amount of expense across all types of local educational agencies. The above statistics for Shanghai and California (Fig. 24) shows that the proportion of expenditure on elementary education in the total expense for K-12 education has remained at about 19% over the past few years, which is similar between Shanghai and California. It suggests that the relative importance of elementary education in K-12 education is comparable between these two regions in terms of educational expenditure.

3.3.2 Student–Teacher Ratio

For Shanghai, the student–teacher ratio is calculated based on the elementary school enrollment and the number of full-time elementary school teachers retrieved from the *Shanghai Educational Yearbook* (Shanghai Municipal Education Commission, 2017, 2018, 2019, 2020).

For California, the elementary education enrollment (Grade 1–5) is calculated based on the *Annual Enrollment Data* found on the website of the California Department of Education (2022), by multiplying the total number of K-12 enrollment and the total proportion of students enrolled in Grade 1 to 5. Regarding the number of teachers, information is retrieved from the staff demographic data found on the website of the California Department of Education (2022). Based on this teacher-level dataset, teachers who had qualification to teach in elementary school

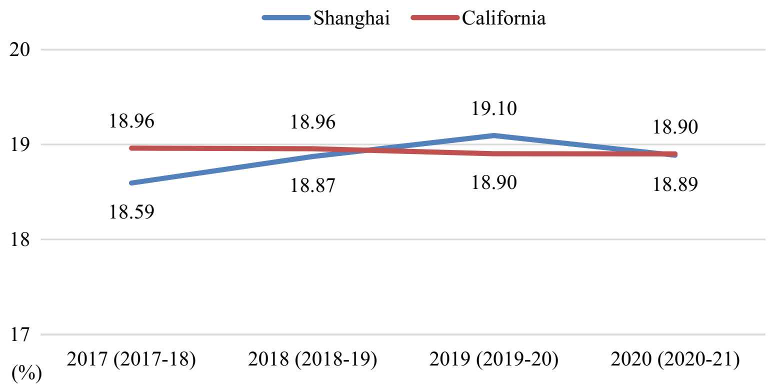

Fig. 24 Percentage of expenditure on elementary education in the total expenditure on regular K-12 education (%). *Source* National Bureau of Statistics (2018, 2019, 2020, 2021b); California Department of Education (2022)

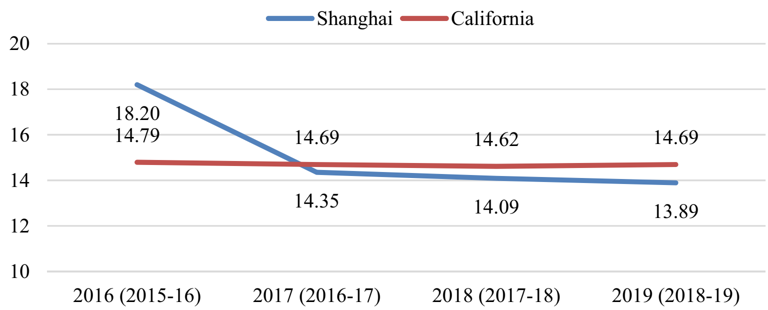

Fig. 25 Student–teacher ratio in elementary education. *Source* Shanghai Municipal Education Commission (2017, 2018, 2019, 2020); California Department of Education (2022)

and whose full-time equivalent (FTE) teaching duties were 100 are selected. Based on the number of students and the number of teachers in the most recent years that are available, the student–teacher ratios in Shanghai and California are calculated.

As shown in Fig. 25, Shanghai and California are comparable regarding the student–teacher ratio in elementary education, which has remained at about 14% in the recent a few years in both regions.

3.3.3 Highest Level of Education Received by Elementary School Teachers

For Shanghai, the highest level of education received by full-time elementary school teachers was identified based on the *Educational Statistics Yearbook of China* (MOE, 2019, 2020a, 2021a), in which the total numbers of elementary school teachers

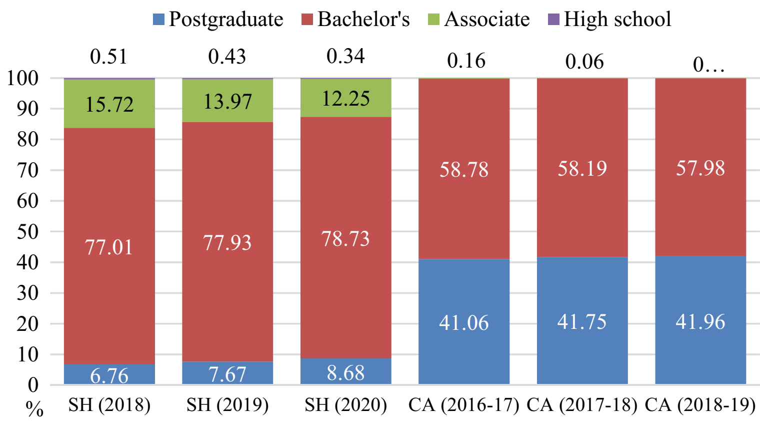

Fig. 26 Highest level of educational degree received by full-time elementary school teachers in Shanghai (SH) and California (CA) (%). *Source* MOE (2019, 2020a, 2021a); California Department of Education (2022)

whose highest level of education fall into each of the four categories are reported: postgraduate degrees, bachelor's degree, associate degree, high school diploma.

For California, the information on teacher education is presented in the *Staff Demographic Data* on the website of the California Department of Education (2022). This dataset include teacher-level information, where there are 10 types of teacher education, which are regrouped into three large categories for the comparison between regions: postgraduate degrees ("Doctorate", "Special", "Master's degree plus 30 or more semester hours", and "Master's degree"); bachelor's degree ("Fifth year within bachelor's degree", "Fifth year induction", "Fifth year", "Baccalaureate plus 30 or more semester hours", and "Baccalaureate"); and associate degree. The available statistics for the latest few years are included in the current comparison.

As presented in Fig. 26, the education degree of elementary school teachers in Shanghai is significantly behind California. In Shanghai, the vast majority (above 77%) of the full-time elementary school teachers had a bachelor's degree as their highest level of education, more than 10% held an associate degree or a high school diploma, and only about 8% had postgraduate degrees. In comparison, more than 40% of the full-time elementary school teachers in California had postgraduate degrees, about 60% held a bachelor's degree, only very few had an associate degree, and no teacher had a high school diploma or below.

3.3.4 Elementary Education Completion Rate

The elementary education completion rate at the regional level within various countries is included in the *World Inequality Database on Education* (OECD, 2022b). The available completion rate information for Shanghai and California is presented in Fig. 27, which is above 99% for both regions regardless of the method of calculation.

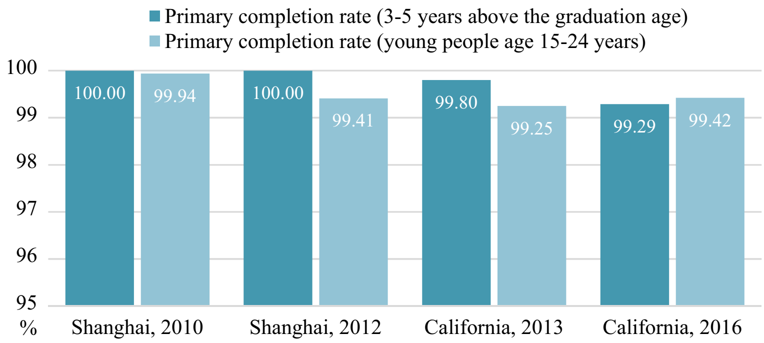

Fig. 27 Elementary completion rate by OECD (%). *Source* OECD (2022b)

3.4 Discussion

In sum, our findings show that, for elementary education, Shanghai has been comparable with California regarding student–teacher ratio and the education completion rate. However, Shanghai is significantly behind California regarding the proportion of elementary school teachers with postgraduate degrees. Additionally, the expenditure on elementary education per student has been significantly lower than that in California, although the public expenditure by student in Shanghai has been steadily growing during the past few years and the proportion of public expenditure on elementary education among the total expenditure for the entire regular K-12 education is comparable between these two regions.

The above indicators might not capture the whole picture of elementary education in either region, since most of them mainly speak to structural quality (i.e., regulable characteristics such as student–teacher ratio, enrollment rate, and teacher education), while information on process quality (i.e., students' daily experiences in instructional activities and social interactions) is missing in public accessible database and yearbooks. However, researchers suggest that although process quality arguably may be more critical to students' learning and development than structural quality, these two camps of quality indicators are interrelated (e.g., Slot et al., 2015). For instance, with a lower student–teacher ratio or a smaller class size, each student would be able to receive more attention and better support from teachers (e.g., Pianta et al., 2005); teachers with richer pre-and in-service training may gain greater competencies in teaching, which could lead to higher process quality, such as better instructional designs and warmer teacher-student interactions (Brühwiler & Blatchford, 2011). Nevertheless, the following sections of this chapter go beyond statistics, aiming to present a more vivid picture of elementary education in China through qualitative examinations of educational practices, policies, and the latest research.

4 Best Practices

4.1 Emphasizing Teacher In-Service Professional Development

Elementary education in China emphasizes teachers' professional development and morality building so as to ensure high-quality educational services. For this purpose, elementary schools in China have adopted various approaches, such as arranging group learning and seminar discussions, setting role models, and peer evaluation. As elaborated below, the practice in the Mengyuan Elementary Education Group is presented as an example, which is a group of elementary schools located in Hefei city, Anhui province, east China.

First, the school holds collective training programs and study tours for teachers to enhance their skills and competencies in teaching. For instance, junior teachers typically need to complete "three lessons a year" with support from a team of mentors, in which they refine their lessons iteratively with suggestions from mentors before giving an entry-level lesson as an evaluation, an intermediate lesson as a report, and a final lesson as a demonstration. Second, the leadership group holds workshops and activities regularly for team building and mentoring purposes, in which teachers share their experiences, learn and seek help from each other. Third, the ethical committee of the school regulates and evaluates teachers' ethical performance, based on which various types of rewards are established, such as *responsible teachers*, *advanced teachers with virtues*, *outstanding master teachers*, and *outstanding education practitioners.*

The practices of Mengyuan Elementary Education Group reflect a teacher training system featured in Chinese elementary education, which emphasizes on teacher professional development and moral development. Junior teachers are well-supported by a collective effort from senior teachers and peers through various activities, such as team buildings, co-developing lesson plans, and professional workshops. Collective effort among colleagues is unique and has demonstrated a great advantage of the socialist system in facilitating teacher professional development and promoting high-quality educational services.

4.2 Dedicated to Students' Physical and Mental Well-Being

Students' physical and mental health has always been a major focus of elementary education. East Beijing Road Elementary School in Shanghai, is taken as an example to present the joint effort of teachers, parents, and society in promoting students' physical and mental well-being throughout elementary education.

First, the curriculums in school are committed to the philosophy that "health comes first". It offers adequate class hours of physical education (P.E.) classes covering a wide range of sports, where students can enhance their physique and build a well-rounded personality through physical exercise. Through collaborative teaching research on P.E. classes, schools reinforced the strategy of “learning, practicing, and competition”, aiming to ensure every student can master at least one or two sports skills. To diversify teaching strategies, the P.E. classes have incorporated augmented reality (AR) technology in sports interactions, which could effectively help with the shortage of sports fields and may serve as an alternative teaching approach when outdoor sports are restricted by weather, season, or other factors.

Second, mental and physical health examinations offered by the school are customized to students. The examination report specifies individual students’ physical examination results and self-reported learning adaptive ability, through which parents and teachers can closely monitor students’ health conditions. Regarding health intervention, for instance, the school has established a three-level intervention system for students’ myopia, which enhances students’ awareness to take autonomous care of their eyes, offers group intervention for nearsighted students, and integrates medical resources and targeted prescriptions for students with serious cases.

Third, the school emphasizes home-school cooperation in facilitating students’ mental and physical development in and out of school. The school organizes a series of activities featuring health education for parents, such as workshops, committee talks, and WeChat pushes on health-related topics, aiming to promote parents’ engagement in health education and therefore better support students’ development. For example, in a newsletter for parents, the school calls for parents to spend more time with their children and to supervise children in maintaining a healthy schedule. Additionally, the newsletter was accompanied with a video from ophthalmologists, where they introduce an episode of eye exercise tailored for elementary school students, to support parents in supervising students in taking care of their eyesight.

East Beijing Road Elementary School’s focus on students’ well-being is shared broadly across the educational system. Elementary schools in China are dedicated to promoting the lifelong development of each student through systematic and individualized physical education plans. Meanwhile, the importance of home-school cooperation is well-recognized. Collaborative efforts from school, home, and community aim to provide a solid foundation for individuals to achieve healthy lives from the beginning of school years.

4.3 Advocating the Philosophy of Enjoying Learning, Enjoying Childhood

Elementary education in China has adopted a philosophy of enjoying learning and enjoying childhood, which suggests that elementary school students should be released from heavy-loaded learning tasks assigned by adults and be allowed to enjoy a happy and fulfilling childhood. “Enjoying learning” does not only refer to positive emotions, but also is associated with a sense of fulfillment, as students acquire knowledge and skills, experience love and social connections, and pursue merit and morality in the process of learning activities. In particular, the “Double Reduction” policy was implemented by the Chinese government in 2021 to ease the burden of excessive homework and off-campus tutoring for students undergoing compulsory education (for details, please see Sect. 7.4). It calls for schools to enrich students’ experiences within schools. Upgrading after-school service is one of the major approaches.

For example, the Elementary School Attached to Wuxi Normal School located in Jiangsu Province in southeast China, has been recognized as one of the seven model schools by the State Education Commission (the predecessor of MOE) of China to promote this philosophy nationwide since the 1970s. The school recognizes the uniqueness of childhood in life-long development and respects peer norms and culture among children, based upon which they developed featured curriculum. The curriculum includes age-appropriate skills across domains, such as language, math, and art, with emphasis on cultivating five merits among students, which are initiation, independence, uniqueness, collaboration, creativity, and responsibility. The implementation of all-round education and the philosophy of “enjoying learning, enjoying childhood” in the Elementary School Attached to Wuxi Normal School is in line with Chinese government’s call for reducing students’ excessive burdens in K-12 education. Elementary education in China emphasizes the importance of students’ individual needs and motivation in learning, so as to foster their well-rounded competence beyond mastering knowledge even when classroom instructions focus on certain subject domains.

Another example is the New World Experimental Elementary School Affiliated to Shanghai Theatre Academy in Pudong district, Shanghai. To design an after-school program that is enjoyed by students, trusted by parents, and recognized by society, the school developed a “one principle, two teams, and three strategies” framework. “One principle” refers to the full coverage principle that the after-school program should cover all the students who would like to participate during weekdays. “Two teams” refer to collaborations between a faculty team consisting of full-time teachers within the school and a volunteer team recruited outside of the school. “Three strategies” refer to thoughtful designs implemented in student application, program activities, and staff benefits. Regarding student application, the school features flexibility for students and their families in choosing after-school services that meet their diverse needs. Students can choose to enroll in a short-term or long-term after-school program and can also choose among three durations each time (i.e., after school to 4:30 pm, to 5:30 pm, or to 6:00 pm). Regarding program activities, various after-school activities are offered to meet students’ various interests, which can be grouped into three categories: physical activities including sports and dance, academic activities including tutoring and consulting services, and art and science activities including both social science and natural science-related topics. Regarding staff benefits, due to the extended workload associated with the after-school services, the school provides a certain degree of flexibility in accounting faculties’ working hours and offers performance-based incentives and awards for faculties. The after-school services offered in the New World Experimental Elementary School Affiliated to Shanghai Theatre Academy addressed the national call of reducing students' excessive burdens. *By* carefully design featured after-school services, *elementary* schools are committed to meet students' individual needs and are dedicated to supporting teachers in balancing their working hours.

5 Inspiring Stories

5.1 Lai Xuanzhi: Cultivating World Champions from a Remote Village

Qixing Elementary School is located in a remote village in Guangdong province, south China. It mainly serves children of migrant workers and those who were left behind by parents working in a different city. In this school, there is a legendary physical education teacher, called Lai Xuanzhi. He established a jump rope team that has been leading elementary school students there setting world records one after another. For instance, at the World Rope Skipping Championships in 2016, the team won the group championship, broke five world records, and became "a dream team" of rope skipping in the world. At the Jump Rope World Cup in 2019, 17 students from the team won 85 gold medals and broke seven match records with competitors from 26 countries and regions.

When Lai started to work at the school right after graduating from the Wuhan Institute of Physical Education in 2010, he was shocked by the great shortage of sports facilities. To meet students' needs for sports, he repaired damaged sports equipment whenever he had time and paved the playground with a hoe every day after work. These efforts earned Lai the nickname "the director of logistics" at the school. In 2012, Lai started to feature rope skipping in his teaching, considering it a potential breakthrough for the students to connect with the bigger world outside of this small village. Through years of exploration, Lai has been advancing his teaching strategies. Under his instruction, more than 30 world champions and 11 world records have emerged from the school team. Rope jumping has become an essential part of the school culture, which gains more resources and attention for the school and, in return, uplifts the educational quality of the remote village. In addition to promoting rope skipping within his school, Lai also shares his expertise and wisdom with other schools, driving the spirit of sports in the broader community.

Lai's commitment and success are driven by his personal experiences and the benefits he saw from participation and excellence in sports during his childhood. He is dedicated to serving the next generation as a P.E. teacher, aiming to support children who are born in less favorable situations. Lai is just one example of numerous educators serving rural areas in China. Regardless of the challenges of conducting high-quality education in the remote villages, educators there have been trying their best to accommodate students' needs and advance their teaching strategies, to better support student success.

5.2 Long Jihong: Empowering Individual Students

Long Jihong is the present principal of Datong Elementary School in Hunan province, south China. She has served as the principal of eight elementary schools in the Furong district with extraordinary teaching performance acknowledged by the Changsha Municipal Education Bureau.

Long invited a team of educational experts to develop a system of curriculum, called *Meili Yuan* (which translates to beautiful garden) and aims to support students' individual needs and unique characteristics. The curriculum includes over 50 elective courses in four categories—life and health, roles and responsibilities, interaction and cooperation, and creativity and aesthetics. These courses aim to promote students' awareness of health and responsibilities and their abilities to communicate with others and appreciate the beauty of life. Many featured courses are tailored to students at different grades, such as Future Nova Host, Slam Dunk, Little Manager of Emotion, etc. One of the most popular courses is Healthy Little Kitchen, in which students learn cooking skills such as making pastry, pan-fried eggs, and cold noodles as well as knowledge about nutrition. When the curriculum registration system went online for the first time, it only took about 10 min for all the 50 + courses to be registered by over 1,000 students. Since then, this curriculum has been promoted around China and has won multiple awards at the provincial and the national level.

As Long suggests, schools should be committed to igniting and inspiring students' passion, creativity, and self-regulation. If there is a morning bell awakening children's souls every day, teachers and all educational practitioners are to be perseverant bell ringers. The curriculum should serve as a tool, encouraging students to pursue their interests, providing opportunities for them to discover their talents, and supporting their autonomy and self-regulation in lifelong learning.

5.3 Yu Yedong: Sowing the Seeds of Science in Students' Hearts

In 2008, an elementary school student called Yu Danyang won the gold medal in the 23rd China Adolescents Science & Technology Innovation Contest. Danyang is one of many students supervised by Yu Yedong, who supports elementary school students in making inventions based on their everyday life, such as walnut crackers, vegetable slicers, and anti-fog mirrors. Yu believes that educators need to help students gain competencies and perseverance in science and technology, to prepare them for the future (Jiang et al., 2015).

Since becoming the principal at Dongsheng Elementary School, Yu has led teams to develop customized courses for the school, including Approaching Science, Voyage in the Sea of Books, Fun with Math, and Fun with English, to enhance students' autonomy in learning through collaboration and inquiry. In language art classes, teachers promote students' critical thinking skills by encouraging students to ask questions; in math classes, teachers facilitate students' divergent thinking by encouraging them to figure out a problem with as many solutions as possible; in science classes, teachers supervised students in conducting surveys and interviews and encouraging them to connect scientific and technological innovation with the larger classroom of society. Further, Yu has launched a science and technology program at the school to facilitate students' motivation, competency, and efficiency in learning. This program includes seasonal festivals and more than 20 guest lectures per year, which allows students to learn and to think across disciplines based upon problems and issues grounded in their own experiences.

The practice of Yu reflects the trend of Chinese education, which emphasizes bridging the knowledge in textbooks with students' everyday lives, since the beginning of the formal school education. Through observing and identifying problems in real-life and conducting scientific reasonings and examinations, students are encouraged to put their unique ideas into practice, which cultivates an innovative spirit, shapes their attitudes and beliefs towards science, and fosters beliefs as lifelong learners.

6 Latest Research

6.1 An Overview of Research on Elementary Education in China

Academic articles written in Chinese focusing on elementary education and published between 2012 and 2022 are searched in a major Chinese academic database - China National Knowledge Infrastructure (CNKI). The total number of articles found is 768,485. The frequencies of the 20 most-used keywords in these articles are retrieved from the CNKI database and these keywords are grouped into themes. As presented in Fig. 28, the most studied theme is Chinese language arts education, which includes keywords such as Chinese language arts (*xiaoxue yuwen*) in elementary schools, Chinese language arts classrooms (*xiaoxue yuwen ketang*) in elementary schools, Chinese language arts instruction (*xiaoxue yuwen jiaoxue*) in elementary schools. The second most studied theme is education and teaching strategies in math, which includes keywords such as math in elementary schools (*xiaoxue shuxue*), math instruction in elementary schools (*xiaoxue shuxue jiaoxue*), and math classroom in elementary schools (*xiaoxue shuxue ketang*). The third most studied theme is education and teaching strategies in English language, including keywords such as English in elementary schools (*xiaoxue yingyu*) and English language teaching in elementary schools (*xiaoxue yingyu jiaoxue*). Meanwhile, emphases have been drawn to students' core competencies (*hexin suyang*), P.E. (*xiaoxue tiyu and xiaoxue tiyu jiaoxue*), music education (*xiaoxue yinyue*), and information technology (IT) (*xinxi jishu*).

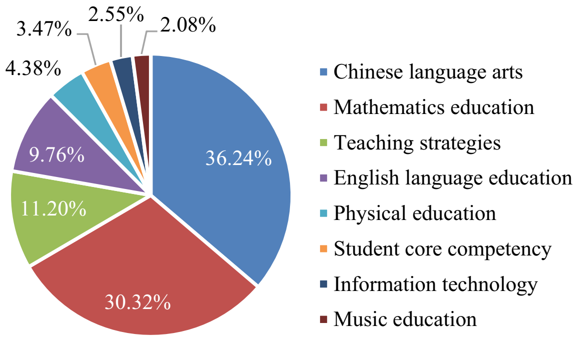

Fig. 28 Research themes in Chinese research focusing on elementary education. *Source* Compiled from search result in CNKI

6.2 Research Focus and Originality

Featured topics in Chinese educational research and practices focusing on the elementary education stage can be summarized into the following three: emphasizing the all-round development of students, promoting educational equity and justice across regions, and protecting individual differences and creativity. Each of these themes is elaborated in the sections below.

6.2.1 Holistic Development (*Quanmian Fazhan*)

Elementary education in China emphasizes students' all-round development, which is grounded in everyday instructions in each subject domain. For instance, Li (2004) discusses a reading-and-writing integrated teaching mode, which treats reading as the foundation for writing and regards writing as an opportunity to promote reading. Su (2004) discusses that math education in elementary school should invite students to engage in observation, analysis, analogy, supposition, induction, generalization, and deduction, so as to promote the development of divergent thinking and critical thinking. In terms of English education, Lu (2021) emphasizes the importance of real-life scenarios in helping students learn to use English in context and enhancing their awareness and competencies in cross-cultural communication.

One major feature of the holistic education in elementary education in China is "Integrated Education", which refers to the integration of five education domains: moral, intellectual, athletic, aesthetic, and labor education (Zhu, 2003). For instance, Jia (2018) discusses a moral education approach based on tea culture. Liu (2021) proposes incorporating traditional dough sculpture in elementary school art education. Shi and Zhao (2022) integrate labor education and science education in elementary schools through STEM curriculums. Further, Zheng (2021) suggests that Integrated Education should be intentionally incorporated into instructions with thoughtful discussions among teachers' co-design of lesson plans.

Another major feature of the all-round education is future orientation, focusing on cultivating students' competencies to become lifelong learners. For instance, Liu (2001) discusses the essential role of information and technology education in cultivating lifelong learners in elementary and secondary schools. Zheng (2014) reports a farewell curriculum designed for students prior to their elementary school graduation, which includes three components: experiencing life in middle school, graduation travel, and critical thinking on social issues. Xiao et al. (2021) develop an instrument assessing elementary students' competencies in STEM with particular emphasis on analyzing and solving problems with interdisciplinary knowledge, which is believed to be essential for students' learning in later school stages. Similarly, Yu et al. (2021) develop an evaluation framework for mid and upper grade elementary school students, targeting their skills in searching and utilizing information via technologies.

Additionally, researchers have emphasized the importance of meeting students' needs and gaining competencies in physical exercises. Peng and Liu (2015) discuss the essential role of physical education in childhood and early adolescence in building perseverance in engaging in physical experiences regularly, so as to lay a solid foundation for students' lifelong participation in sports. Feng (2021) emphasizes the critical influence of school culture in helping students form a lifelong affinity for sports. Further, Huang (2020) suggests turning elementary school students into "facilitators of sports and health" in their community so as to strengthen students' competencies and beliefs in living healthy lives. In sum, it has been well recognized that elementary schools play an essential role in building a solid foundation for future citizens to live a healthy and happy life by providing access, guidance, and support for students to engage in sports activities and shaping their beliefs in healthy lives.

6.2.2 Promoting Educational Equity Between Schools and Regions

To address the issue of unequal distribution of education resources between "top-notch" schools and other schools in the same city, the "Enrollment based on Local Residency" (*jiujin fenpei*) policy suggests that all students should be able to receive compulsory education services in the school district based on the place of residence of their household registration regardless of the students' academic abilities or their family background. Researchers discuss that this policy represents the interests of the vast majority as it could facilitate the integration of the educational resources across social classes (Huang, 2016; Zheng & Wang, 2014). However, Shao (2019) discusses two essential aspects of implementing the nearby enrollment policy to provide high-quality education for all students: one is the collaboration between public and private education institutions, and another is evidence-based admission policy and procedure with support from information technology. Further, to address educational inequality within schools, tracking has been discouraged or forbidden in more and more cities. Instead, Zhang (2021) proposes an "ecologically balanced" approach to increase diversity within classrooms, which includes factors such as students' interest and specialization, and family background and parenting styles.

The unequal distribution of educational resources across regions in China has been well-recognized that the rural and the Middle and Western Parts of China has a greater shortage in educational resources than their economically more developed counterpart. One major aspect of the shortage is high-quality teachers. To address this challenge, on the one hand, the *National Training Plan for Elementary and Secondary School Teachers* (or the *National Training Plan*) put forward by the Chinese government is aimed to promote professional development for in-service teachers in regions of need. Researchers discuss that, through top-down designs and evidence-based teacher education, this plan significantly improves teachers' competencies in instruction, facilitates professional development, and promotes nationwide public welfare (Cui et al., 2019; Zhu, 2010). On the other hand, the *Special-Post Teacher Recruitment Program* (or the *Special-Post Program*) jointly launched by MOE and three other departments aims to increase teacher quality in regions in need from the start, by recruiting high-quality college graduates to serve elementary and middle schools in rural and the Middle and Western Parts of China. It is believed that this program upgrades the staffing structure in rural areas (An & Ding, 2014) and creates new employment options for college students, which helps alleviate their job-searching anxiety and offers opportunities to actualize their goal of making a difference (Shi, 2006).

In addition to the above national plans, researchers have discussed other approaches to promoting educational equity across regions. For instance, Chen et al. (2019) discuss training all-subject teachers in rural schools, who would not only be content experts across subject domains but should deeply believe in education as a way to shape the future, even for children growing up in unfavorable conditions. Shi (2011) discusses a teacher exchange program, which allows the mobility of educational resources as urban teachers serve as volunteers in rural schools in turn. Sheng and Zhang (2021) discuss building Hope schools in remote areas with a joint effort between the schools and the local communities.

Besides improving teacher quality, financial support has been provided to rural students from impoverished families during compulsory education. For instance, the "Two Exemptions and One Subsidy" policy is a national policy, which provides rural students with free textbooks, exempts them from miscellaneous fees, and subsidizes certain living expenses for them. Researchers have discussed that the policy has diminished economic obstacles for numerous students in need, accelerated the popularization of free compulsory education in rural regions, and has made a significant achievement in reducing poverty, which optimizes the configuration of education resources and supports the nation in realizing sustainable economic and social growth (Li, 2008; Nong, 2015).

6.2.3 Supporting Autonomy and Creativity

Elementary education in China values students' autonomy in learning and creative thinking. Taking research focusing on language art in elementary schools as an example, researchers suggest that reading and writing are processes of individualized learning and creating, where personalized observations and unique perspectives would be valued, rather than being trimmed based on certain obsolete right answers for the sake of standardized testing (Cao, 2009). To achieve this, Du (2021) highlights the importance for educators to observe students' individualized reading experiences and support students' autonomy in reading. Specifically, Ge (2022) proposes a form of writing workshops, where students engage in topic selection, brainstorming, writing, and revision. During the process, students and teachers can discuss as partners with equal status, and conversations among peers are encouraged so as to engage and inspire students in creative writing.

Similarly, autonomy and individual differences are highly valued in instructions in other subject domains. In the context of math education, Meng (2019) discusses learning contexts customized for elementary school students from three aspects—learning environment, learning content, and learning strategies. In arts education, Yu (2016) discusses the importance and values of students' unique expressions in instructional moves, such as appreciation, creation, and evaluation. Further, Li (2020) advocates the project-based learning approach for school-based curriculums, where students are allowed to customize their learning by engaging in in-depth discussions with teachers and collaborations with peers. Even for homework assignments, Peng (2014) proposes that teachers and students should be partners in co-designing assignments to meet individualized instructional goals, which is specified by Lin (2021) as a hierarchy of homework—basic homework, extended homework, and innovative homework.

Creativity has been highly valued in elementary education in China. Ren and Qi (2020a, 2020b) discuss an instructional pattern that could facilitate innovative thinking, which is divided into five instructional moves including induction, creation, design, realization, and summary. Qiu (2021) emphasizes the essential role of collaborative learning in cultivating spirit and competencies in creativity, where students collaborate with peers in exploring novel ideas driven by issues grounded in practice. From the assessment perspective, Liu and Mencius (2011) develop a creativity assessment scale for elementary and secondary school students, which includes three dimensions: creative personality, sense of creativity, and creative thinking. Feng (2017) develops a scale assessing creative problem-solving skills for elementary school students based on the information processing theory, which includes identifying problems, processing information, and analyzing and solving problems.

7 National Policies

7.1 Policy Development on Elementary Education in China

Fundamental educational policies regulating elementary education in China can be grouped into two major categories. One focuses on teacher professional development and another focuses on student all-round development. A part of all-round development is students' physical and mental health, which is elaborated in Chap. 10 of this book.

7.1.1 Teacher Ethics and Professional Development

Professional Ethics for Elementary and Secondary School Teachers (MOE, 2008) emphasizes Chinese fine traditions of teachers' ethics and reflects the increasing demands from the society regarding the professional development for teachers in elementary and secondary schools. The document defines teacher professional ethics from the following six aspects: patriotic and law-abiding, devoting to work, caring for students, delivering knowledge and cultivating spirit, being exemplars for students, and lifelong learning. The document is a guideline for educational practices and has served as criteria for evaluating teachers' interactions with students, schools, and society. Below is a clause from the document, as well as that from two subsequent policies.

> Elementary and secondary schools should prioritize teacher ethics development, which needs to be incorporated into the whole process of teacher professional development and evaluation.
>
> – *Guidelines on Building the Long-term Mechanism of Teacher Morality Construction in Elementary and Secondary Schools* (MOE, 2013)
>
> Training programs for in-service teachers of elementary and secondary schools should address the needs of the nation and the requirements of the society of the times. The design of teacher training programs should take related theories and practices at home and abroad as references, which is encouraged to include the following four modules: ideal and faith, moral sentiments, solid content knowledge, and love and benevolences.
>
> – *Guiding Standards for Elementary and Secondary School Teacher Training Curriculum (Teacher Morality)* (MOE, 2020b)

7.1.2 Student All-Round Development

There have been several national policies dedicated to promoting all-round education in the stage of elementary and secondary education. It has been well recognized that students' learning outcomes should be evaluated beyond testing scores, and also include a focus on merit, creativity, and all-round development (MOE, 2008). As shown in the clauses below, these policies cover domains such as art, physical exercise, and moral development:

> The evaluation of students' learning outcomes in art education should adhere to theories and science in education, and child development. It should simultaneously consider students' learning in the art classroom and their experiences in artistic practices, should highlight students' learning achievements as well as their learning attitudes, and should keep a balance between designing basic requirements for all students and encouraging specialized students based on their interest and strength.
>
> – *Methods for Evaluating the Artistic Quality of Elementary and Secondary School Students* (MOE, 2015)
>
> P.E. should reflect the notion of educational equity. The government and schools should ensure every elementary school student's right to receive physical education. Facing the reality of imbalanced development across regions and between the rural and urban areas, the *Standard* regulates physical equipment and facilities in elementary schools by clarifying

two categories of requirements: basic and optional. The basic requirements are compulsory regulations for all elementary schools, and the optional requirements allow autonomy and serve as goals for schools.

– *Equipping Standard of Equipment and Facilities for Physical Training in Elementary Schools* (MOE, 2020c)

Labor education should be incorporated in elementary school through college. In lower grades in elementary schools, labor education should be grounded in children's personal living needs. With safety awareness embedded throughout, the goal of labor education at this stage is to help children understand that everyone needs to work in society and to provide opportunities for them to enjoy working and cherish the fruitful results.

– *Guidelines on Labor Education for Elementary, Secondary, and Higher Education (Trial)* (MOE, 2020d)

Moral education plays a big role in elementary and secondary education. In middle and upper grades in elementary school, students should be offered opportunities to understand the culture, history, and development of their hometown as well as the country. Based on stories in daily life and those shining through Chinese culture and history, students gain a sense of social norms, develop merits, and enhance their love for the country and people.

– *Guide to Moral Education for Elementary and Secondary* Schools (MOE, 2017)

7.2 Current Policy Highlights

In recent years, significant effort in elementary education in China has been spent on easing students' excessive burdens, which is driven by the *Guidelines on Further Easing the Burdens of Excessive Homework and Off-Campus Tutoring for Students Undergoing Compulsory Education* (the State Council, 2021). The document is released in the social context where the on-campus formal education seems to be overshadowed by extensive off-campus tutoring institutions during the stage of compulsory education, which has created significant mental and financial burden to students and their families. To bring students back to campus, the document indicates that, besides regulating off-campus tutoring practices, it is critical to improve the quality of teaching and other educational services offered on campus. To achieve this goal, the document provides lots of guidance to schools, such as designing homework assignments based on scientific evidence and reducing the amount of time students need to spend on homework as much as possible, implementing after-school services to address students' diverse needs, and optimizing educational administration practices to better supports students and teachers. Below are quoted clauses and a follow-up policy.

Standards regarding the total amount of homework across subject domains in each educational stage need to be established. For elementary school students in the first and second grades, they should not be given any written assignments that have to be finished at home, although they may take a certain amount of exercises in school to reinforce what they have learned. For third to sixth graders, their written assignments should not take more than 60 minutes on average, and that for middle school students should be kept under 90 minutes.

– *Guidelines on Further Easing the Burdens of Excessive Homework and Off-Campus Tutoring for Students Undergoing Compulsory Education* (the State Council, 2021)

Examinations in written formats are not allowed in the first and second grades. For other grades in compulsory education, schools can hold examinations once at the end of each semester. Middle schools may add a mid-term exam based on the practical needs of certain subjects. Regional or cross-school examinations are forbidden throughout compulsory education, except for students in the graduating grade in middle school.

– *Notice on Strengthening the Management of Examinations in Compulsory Education Schools* (MOE, 2021b)

8 Summary

Elementary education is the beginning of formal education and the starting point of compulsory education in China, which serves as the foundation for individuals' lifelong development and the sustainable development of the country. Thus, receiving elementary education is both a right and obligation of every citizen in China.

Nationwide, the number of students and teachers in elementary education in China ranks top in the world. With strong support from the government and great efforts from all educational practitioners, the advancement of public elementary schools is ensured. This is evidenced by the comparable government expenditure on elementary education as a percentage of GDP with most developed countries, the guarantee of fine infrastructure and teachers' qualifications, the high gross enrollment rate and completion rate, and the high proportion of children in Grade 2 or 3 achieving at least a minimum proficiency in math. Further, the comparisons between Shanghai and California demonstrate that they are comparable in many aspects, such as the percentage of expenditure on elementary education in the total expenditure on regular K-12 education, student–teacher ratio, and elementary completion rate.

Nonetheless, elementary education in China still falls behind developed countries in a few aspects, particularly in terms of the expenditure on education per student and teacher education. Although the expenditure on education per student in China is growing in recent years, it is still not comparable with developed countries, which could be explained by the huge population and significant diversity within the country. The importance of high-quality teachers has been well-recognized, which is why normal universities' have been desperate in developing and improving teacher education for pre-service teachers both at the undergraduate and the graduate levels and provide opportunities for professional development for in-service teachers. Further, several top-notch comprehensive universities in China have established graduate programs to advance K-12 teacher education, taking the advantage of the universities' world-class resources and achievement in various subject domains (e.g., the School of Education at Shanghai Jiao Tong University).

Besides comparisons based on statistics, this chapter also qualitatively demonstrates the philosophy and characteristics of elementary education in China through featured teaching practices, contemporary educational research, and critical educational policies. First, morality could not be emphasized enough in Chinese education, which not only refers to cultivating students' virtue but also highlights teachers' professional ethics. Second, students' all-round development and well-being are the ultimate goals of elementary education in China. Beyond content knowledge in certain subject domains, emphases have been drawn on students' physical and mental health, interdisciplinary ability, creative thinking, and the competencies in applying knowledge in solving real-life problems. Third, policies, practices, and research have been going hand-in-hand in elementary education in China. With the evidence provided by educational research, educational policies have been providing guidance and serving as the safeguard for educational practices, such as reducing student burden, promoting all-round development, and addressing the issue of educational equity.

In sum, elementary education in China has been offering a solid and comprehensive foundation for individuals in their early stages of lifelong development. Elementary education in China has been and will further improve its capacity in fulfilling its mission—helping students gain competencies and prepare for the further.

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Chapter 3
Secondary Education (Middle School) in China

Ma Yue

Abstract Compulsory education in China refers to the mandatory, free, and universal education that all school-age children and teenagers receive, which includes six-year elementary school and three-year junior secondary school (middle school). Nine-year compulsory education in China is of great significance because it is closely associated with the healthy growth of hundreds of millions of children, the development of the country, and the future of the nation. This chapter focuses on the latter stage of compulsory education in China, namely the three-year junior secondary education (middle school), and attempts to present the educational landscape by including both quantitative and qualitative information in seven different sections. This chapter first provides an introduction of compulsory education and junior secondary education in China; then it highlights important education data of China in an international context. The third section proposes representative indicators to reflect the excellence level of junior secondary education for China and the world. The next two sections share best practices in the development of junior secondary education and inspiring stories of educators in this sector. It then reviews the latest literature and research focus on the field of junior secondary education. Lastly, the chapter outlines key policy documents on developing junior secondary education. In general, Chinese government has been striving to facilitate the well and balanced development of junior secondary education. Significant progress has been made over the years, yet aspects that should be improved and strengthened are also discussed.

Keywords Junior secondary education · Well-rounded education (*Suzhi* education) · High-quality and well-development · Core competencies

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1 Introduction

1.1 Compulsory Education in China

Since the founding of the People's Republic of China (PRC) in 1949, the low literacy rate had been plaguing the country. According to statistics, over 80% of the population in China was illiterate in 1949, with illiteracy rates in rural areas exceeding 95% (Cheng, 2010). To battle illiteracy, the Chinese government launched several rounds of adult literacy campaigns and proposed various initiatives over the years, including the issurance of the *Compulsory Education Law of the People's Republic of China* in 1986. According to the law, children who reach six years old should be enrolled in elementary schools, and in areas where conditions are not available, the age for children to enter elementary schools could be postponed to seven. Moreover, in places where junior secondary education is universalized, all elementary school graduates should enter nearby middle schools without taking any entrance examinations (National People's Congress, 1986).

Since the implementation of the *Compulsory Education Law*, significant progress has been made in terms of increasing literacy levels in China. In 2001, Chinese government declared that the country had basically succeeded in promoting nine-year compulsory education and in eradicating illiteracy in most areas of the country (Zhai et al., 2012). In 2011, Chinese government announced universal access to the compulsory education system (*ibid*). In 2018, the nine-year compulsory education graduation rate of China reached 94.2%, and there was a total of 213,800 elementary and secondary schools with 149.9 million students (Chu, 2019).

China has achieved one of the highest literacy rates in the world, which is a great achievement given that the country's elementary school enrollment rate was only about 25% in 1949 (*ibid*). More importantly, children in China enjoy more opportunities to enter school and can seek increased equal opportunities to a quality education over the years. In the new era, China continues striving to further improve the quality of compulsory education in a more balanced way. In 2021, the Chinese government launched an initiative to promote the high-quality and well-balanced development of compulsory education at the county level (Xinhua, 2021a). According to a directive *Notice on Promoting Quality and Balanced Development of Compulsory Education at County Level* issued by Ministry of Education (MOE) of China, the initiative will be spearheaded by several county-level areas in each provincial-level region in the next three to five years before being implemented nationwide (MOE, 2021a). Under the initiative, relevant mechanisms are being developed and improved to allow schools greater autonomy and to help stimulate school vitality in their daily operations. Measures are being rolled out to promote the balanced distribution of education resources, and policies are being devised to enhance the education and care of children who do not live with their parents, students with disabilities, and other groups of special need. The goal of achieving a high-quality and well-balanced compulsory education is expected to be fully completed by 2035.

1.2 Junior Secondary Education (Middle School) in China

As part of compulsory education, junior secondary education (middle school) helps ensure the transition from elementary school to senior secondary school is smooth, strong, and consistent for all students, which plays an important role for the healthy development of children, for social progress, as well as for the future of the nation. According to *Educational Statistics Yearbook of China 2020*, the total number of junior secondary schools in China reached 52,805 in 2020, with 13,981 schools in urban areas, 24,583 schools in counties and towns, and 14,241 in rural areas. The total number of entrants to junior secondary schools reached 16,320,964, with 7,567,836 female students and 8,753,128 male students, and the total number graduates of junior secondary school students in 2020 was 15,352,918, with 7,119,444 female students, and 8,233,474 male students (MOE, 2021b).

Junior secondary education in China typically lasts for three years consisting of the seventh through nineth grades. Students of the same grade are divided into different classes. The number of students in each class varies according to the enrollment of a particular year, typically ranging from fewer than 25 students to more than 66 students with the mode between 46 and 55 students (MOE, 2021b). In junior secondary schools, students are required to learn a variety of liberal arts and science subject courses, such as Chinese language arts, math, a foreign language (i.e., English, Japanese), physics, chemistry, biology, politics, history, geography, as well as physical education (P.E.), music, and art. The national prescribed curriculum is supposed to be an extension of that of the elementary school both in depth and size, and thus students are expected to have deeper and better understanding of the course materials. At the end of junior secondary education, students are required to take graduation tests for all the subjects, and those who pass receive a graduation certificate and are eligible to take the senior high school entrance examination (*Zhongkao*). The high school entrance examination is an important local unified examination, which usually takes place annually at the end of June. Student performance on this examination serves as the main admission criteria for senior secondary schools. According to statistics, the promotion rate from junior senior secondary schools to senior secondary schools has been increasing from 40.60% in 1990 to 94.6% in 2020 (National Bureau of Statistics, 2021).

In addition to regular subject courses, students in junior secondary schools also participate in a variety of school-based extracurricular activities (i.e., sports teams, dance clubs), particularly in the context of the “Double Reduction” policy. By the end of October of 2021, it is estimated that 99% of the 143 thousand elementary and middle schools have provided after-school services, 92.7% for physical and art-related activities, 88.3% for reading activities, and 87.3% for science-related or interest clubs (Ding, 2022). Students can choose activities based on their interests. The intent of providing such diverse extracurricular activities is to help students expand their knowledge and widen their vision so that they can be better prepared for the ever-changing world.

Junior secondary school students are also required to engage in community services such as general cleaning. Students take turns to clean their classrooms and the playgrounds once a day in a group. This cleaning requirements are intended to cultivate a sense of personal responsibility and a strong work ethic. Moreover, the *Course Standard of Labor Education of Compulsory Education* published in 2022 also requires students to participate in such activities as cleaning, family cooking, and ceramics (MOE, 2022).

2 Highlighting Data

This section aims to highlight important data on junior secondary education of China in an international context. To be more specific, ten relevant variables are selected from open databases including the Program for International Student Assessment (PISA) and the Teaching and Learning International Survey (TALIS). For comparison purposes, data results for seven developed countries, i.e., the United States (U.S.), Germany, France, the United Kingdom (U.K.), Japan, the Republic of Korea (ROK), the Netherlands, are presented in parallel.

It is worth noting that the target population of the PISA assessment is 15-year-old students, and only selected provinces and/or cities in China (i.e., Beijing, Shanghai, and Jiangsu, Zhejiang) have participated in the assessment. Similarly, only teachers sampled from Shanghai participated in the TALIS assessment. Thus, the following analysis provides only partial insights, and can be only generalized to and represent junior secondary education in the relatively developed regions in China.

2.1 Learning Time Per Week in Total

Students' learning time has been linked to school academic pressure. The total learning time of students per week (minutes) is retrieved from the PISA 2018 dataset. The results are presented in Fig. 1.

As seen in Fig. 1, student total learning time per week ranges from 1592.07 min to 1880.40 min among the eight countries. Students in China tend to have the longest learning time, followed by the U.S., ROK, Japan, France, the Netherlands, the U.K., and students in Germany report the shortest learning time per week.

Moreover, it seems that the learning time of students in the Asian countries (i.e., China, ROK, Japan) is much longer than that of students in the Western countries (i.e., Germany, the U.K., the Netherlands, France), which may relate to the different education systems between the countries.

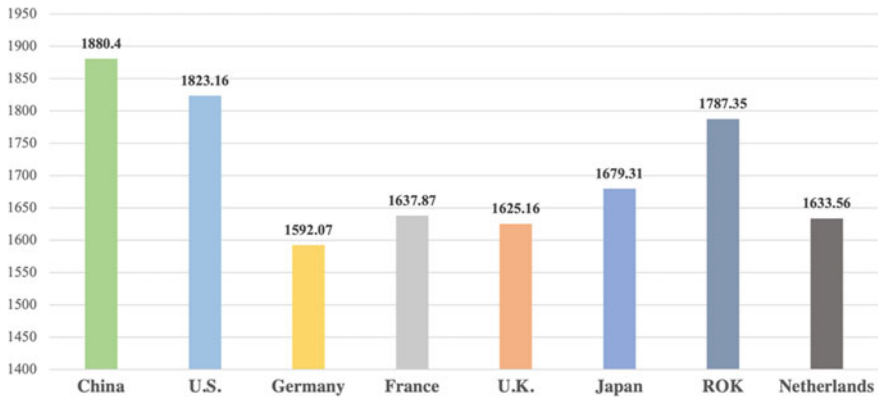

Fig. 1 Learning time per week in total (minutes). *Source* Adapted from OECD (2019a)

2.2 Economic, Social, and Cultural Status

Economic, Social, and Cultural Status (ESCS) is one of the most important predictors of student learning outcomes (Ma, 2021). The PISA 2018 index of ESCS is derived from three variables associated with family background: "parents' highest occupational status", "parents' highest level of education", and "home possessions" (OECD, 2019a). The ESCS scores are transformed to a scale with a mean of zero and a standard deviation of one in PISA 2018. A score above zero means that the socioeconomic status of students in the specific country is higher than the average of the OECD countries, while a score below zero means that the socioeconomic status of students in the specific country is lower than the average of the OECD countries. The results of student ESCS scores are presented in Fig. 2.

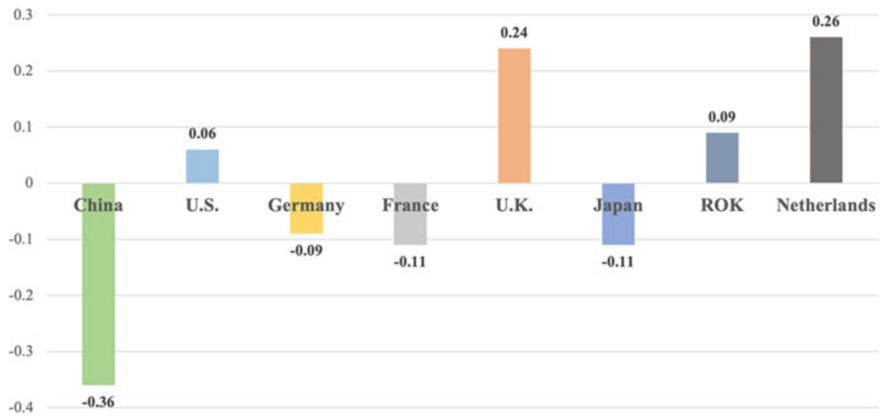

Fig. 2 Student economic, social, and cultural status (ESCS). *Source* Adapted from OECD (2019a)

As seen in Fig. 2, the average ESCS of students shows different levels across the eight countries. Specifically, the ESCS score of Chinese students is the lowest (index score is −0.36), followed by France, Japan, Germany, the U.S., ROK, and the U.K., and students in the Netherlands have the highest ESCS level. The results reflect that China is still categorized as a developing country with the largest student population in the world, while the others are developed countries.

2.3 Academic Literacy

In PISA 2018, 15-year-old student academic literacy in math, reading and science are measured and recorded. Specifically, "mathematical literacy" in PISA 2018 refers to an individual's capacity to "formulate, employ, and interpret math in a variety of contexts" (OECD, 2019a). It includes "reasoning mathematically, and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena" (*ibid*). It assists individuals to recognize the role that math plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged, and reflective citizens. Reading literacy in PISA 2018 refers to the ability to "understand and use those written language forms required by society and/or valued by the individual" (*ibid*). Readers can construct meaning from texts in a variety of forms. They read to learn, to participate in communities of readers in school and everyday life, and for enjoyment. Scientific literacy in PISA 2018 assesses students' content, procedural and epistemic knowledge, as well as scientific competencies to "explain phenomena scientifically, evaluate and design scientific inquiry, interpret data and evidence scientifically" (*ibid*). The results for mathematical, reading, and scientific literacy are presented in Figs. 3, 4 and 5 respectively.

As seen in figures above, Chinese students consistently rank first among the countries in all of the three subjects. Moreover, it seems that students in Asian countries

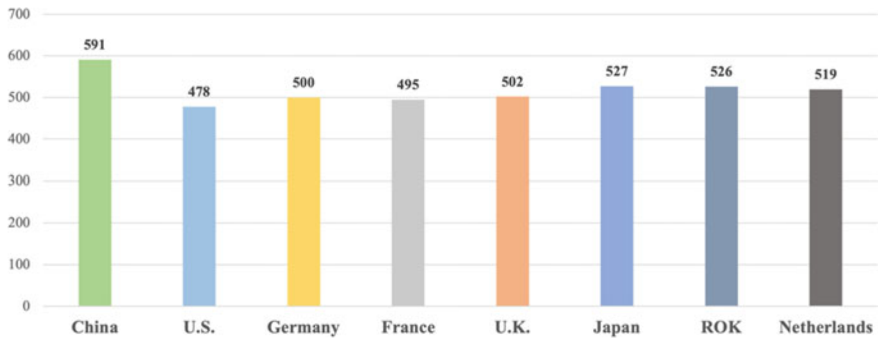

Fig. 3 Mathematical literacy. *Source* Adapted from OECD (2019a)

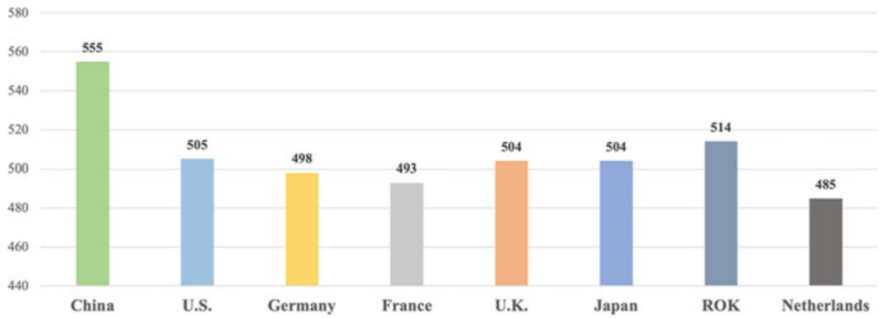

Fig. 4 Reading literacy. *Source* Adapted from OECD (2019a)

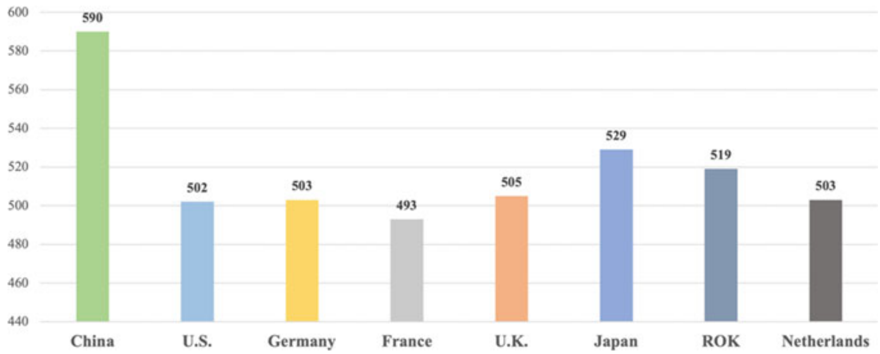

Fig. 5 Scientific literacy. *Source* Adapted from OECD (2019a)

(i.e., ROK, Japan) perform better than their counterparts in the Western countries (i.e., the U.S., Germany, France, the U.K., the Netherlands).

2.4 *Fear of Failure*

In PISA 2018, students are asked to report the extent to which they agree with the following statements: "When I am failing, I worry about what others think of me"; "When I am failing, I am afraid that I might not have enough talent"; and "When I am failing, this makes me doubt my plans for the future". These statements are combined to create the index of fear of failure.

Positive values in this index mean that the student expresses a greater fear of failure than did the average student across the OECD countries. Negative values in this index mean that the student expresses a lower level of fear of failure than the average student across the OECD countries. The results are presented in Fig. 6.

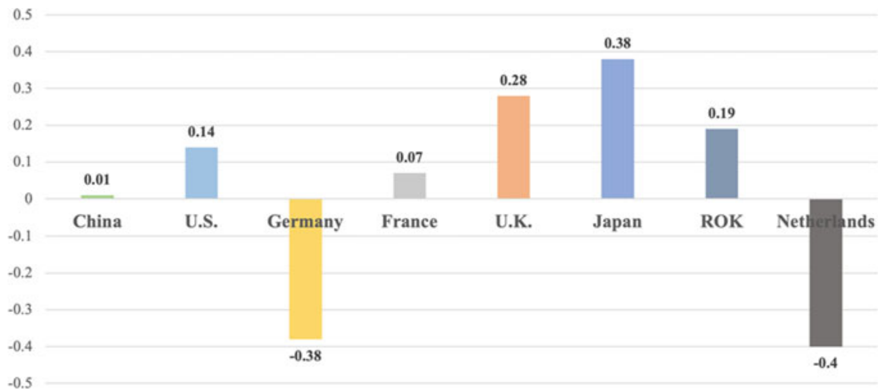

Fig. 6 Fear of failure. *Source* Adapted from OECD (2019a)

As seen in Fig. 6, the fear of failure of Chinese students is at a medium level compared with that of students in other countries. Students from Japan, the U.K., ROK, and the U.S. tend to have higher levels of fear of failure, while students in Germany and the Netherlands tend to have lower levels of fear of failure. The results might occur due to a variety of reasons such as student past success or failure experiences and how school teachers guide students to face failures.

2.5 *Eudaemonia: Meaning in Life*

Perceived meaning in life reflects student attitudes toward life. In PISA 2018, students are asked to report the extent to which they agree with the following statements: "My life has clear meaning or purpose"; "I have discovered a satisfactory meaning in life"; and "I have a clear sense of what gives meaning to my life". These statements are combined to form the index of meaning in life.

Positive values in the index indicate greater meaning in life than the average student across the OECD countries. Negative values in this index indicate lower meaning in life than the average student across the OECD countries. The results are presented in Fig. 7.

As seen in Fig. 7, the level of Chinese students' perceived meaning in life is similar with that of students in the U.S., Germany, France, and ROK. However, students in the U.K., Japan and the Netherlands tend to have lower levels of perceived meaning in life.

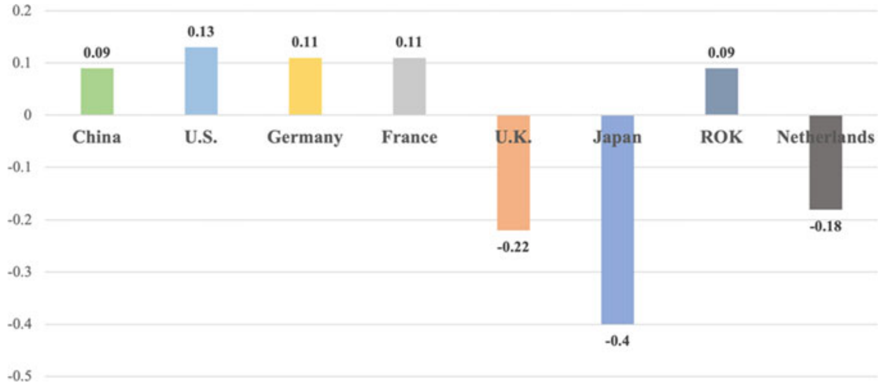

Fig. 7 Eudaemonia: Meaning in life. *Source* Adapted from OECD (2019a)

2.6 Professional Development

Professional development refers to the various activities (i.e., courses/workshops, education conferences, qualification program, observation visits to other schools, mentoring) that can help develop an individual's knowledge and skills, as well as other characteristics as a teacher. In TALIS 2018, teachers from different regions or countries are asked to evaluate how effective they perceive the professional development they have participated in. The results are presented in Fig. 8.

As seen in Fig. 8, the scores of perceived effective professional development ranges from 9.84 points to 14.05 points across the countries. Teachers in China tend to report a relatively lower level of effective professional development (=11.95 points) compared to those from the U.S., France, ROK, and the Netherlands, while it is higher than those from the U.K. and Japan.

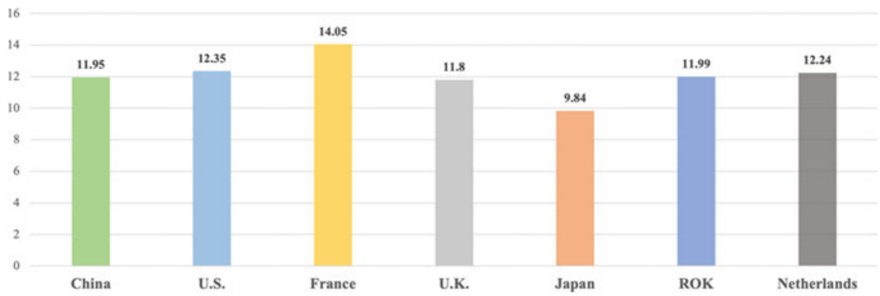

Fig. 8 Professional development. *Source* Adapted from OECD (2019c). *Notes* Germany data are not available

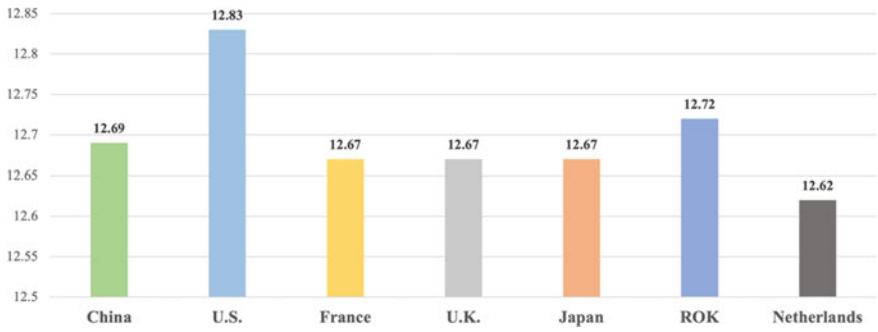

Fig. 9 Teacher self-efficacy. *Source* Adapted from OECD (2019c). *Notes* Germany data are not available

2.7 Teacher Self-efficacy

TALIS 2018 elicits teachers' self-efficacy beliefs by asking them to assess their ability to perform well in a range of tasks related to classroom management, instruction, and students' engagement. The results are presented in Fig. 9.

As seen in Fig. 9, the data of teacher self-efficacy are at similar levels across the countries, ranging from 12.62 points to 12.83 points. In particular, teachers from the U.S. tend to have the highest level of self-efficacy, followed by ROK, China, France, the U.K., Japan, and teachers from the Netherlands tend to report the lowest self-efficacy.

2.8 Teacher Workload Stress

In TALIS 2018, teachers from different regions or countries are asked to report the extent to which they have experienced stress at work. This may reflect education pressure from the perspective of teachers. The results are presented in Fig. 10.

As seen in Fig. 10, teachers in Shanghai of China report lower levels of workload stress than that of teachers in other countries except for France. Teachers in ROK report the highest level of workload stress, followed by the Netherlands, the U.K. (England), Japan, the U.S., China (Shanghai), and then France. In general, it seems that the workload stress of teachers in the Asian countries (i.e., ROK, Japan) is higher than that of teachers from the Western countries (i.e., France, the U.S.).

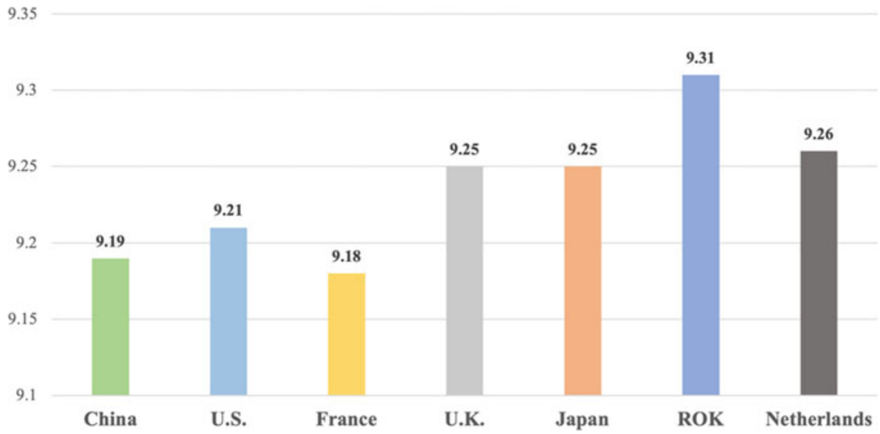

Fig. 10 Teacher workload stress. *Source* Adapted from OECD (2019c). *Notes* Germany data are not available

2.9 Shortage of Educational Materials

PISA 2018 measures school resources by asking school principals' perceptions of potential factors hindering instruction at school ("Is your school's capacity to provide instruction hindered by any of the following issues?"). An index of shortage of educational staff is derived from the following indicators: "a lack of educational material", "inadequate or poorly quality educational material", "a lack of physical infrastructure", "inadequate or poorly quality physical infrastructure" (OECD, 2019a).

Positive values in this index mean that principals view the amount and/or quality of educational material in their schools as an obstacle to providing instruction to a greater extent than the average across the OECD countries. Negative values in this index mean that principals view the amount and/or quality of educational material in their schools as an obstacle to providing instruction to a lesser extent than the average across the OECD countries. The results are presented in Fig. 11.

As seen in Fig. 11, principals in China report a lower level of shortage of educational materials than the average of OECD countries (<0). Also, the value tends to be lower than that of Japan, ROK, Germany, the U.K., and France, while higher than that of the U.S. and the Netherlands.

2.10 Shortage of Educational Staff

Similar to shortage of educational material, PISA 2018 also measures shortage of school resources. An index of shortage of educational staff was derived from

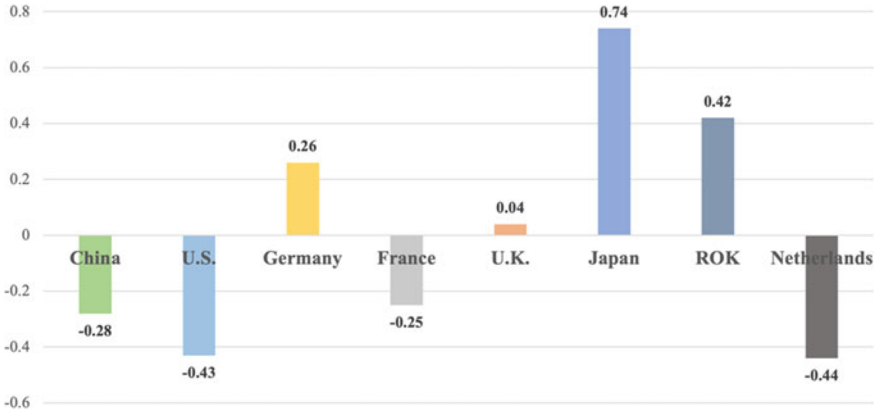

Fig. 11 Shortage of educational materials. *Source* Adapted from OECD (2019a)

following four indicators: "a lack of teaching staff", "inadequate or poorly qualified teaching staff", "a lack of assisting staff", and "inadequate or poorly qualified assisting staff" (OECD, 2019a).

Positive values in this index mean that principals view the amount and/or quality of the human resources in their schools as an obstacle to providing instruction to a greater extent than the average across the OECD countries. Negative values in this index mean that principals view the amount and/or quality of the human resources in their schools as an obstacle to providing instruction to a lesser extent than the average across the OECD countries. The results are presented in Fig. 12.

As seen in Fig. 12, principals in China report a higher level of shortage of educational staff than the average of OECD countries (<0). Also, the value tends to be

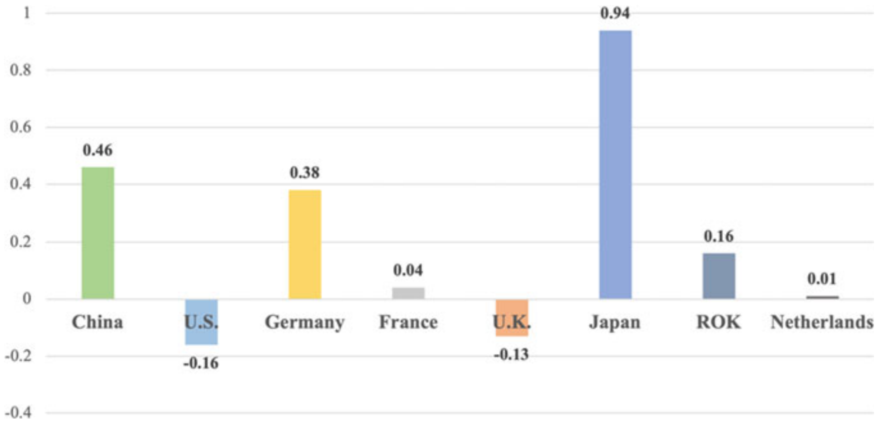

Fig. 12 Shortage of educational staff. *Source* Adapted from OECD (2019a)

lower than that of Japan, while higher than that of the U.S., Germany, France, the U.K., ROK, and the Netherlands.

3 Excellence Indicators

3.1 Design

When it comes to education, excellence is on top of the agenda. Yet, the meaning attributed to the notion of excellence differs remarkably among educators, researchers, and policymakers. This section attempts to propose representative indicators that can comprehensively reflect the excellence levels of junior secondary education for China in a global context.

In addition to China, a total of seven developed countries are selected in this section for comparison purposes, i.e., the U.S., the U.K., France, Germany, the Netherlands, Japan, and ROK. The objective of this section is to allow for a global view of the junior secondary education systems, and to help countries review current education conditions and thus develop informed educational policies.

While selecting the excellence indicators, two general principles or rules are followed, that is, the indicators need to be internationally comparable and provide comprehensive coverage. The indicators should make sense for China and for the world. Moreover, specific data associated with the indicators should also be available for most of the countries. Also, the proposed indicators should comprehensively reflect the excellence levels from different perspectives (i.e., education input, education output) and from different stakeholders (i.e., teachers, students).

Following the above two principles or rules, a total of nine excellence indicators are analyzed in this section, including:

- Total expenditure on junior secondary education per full-time equivalent student
- Student–teacher ratio
- Proportion of teachers fully certified by the appropriate authority
- Student repetition rate
- Student scientific literacy
- Student reading literacy
- Student mathematical literacy
- Student sense of belonging to school
- Teacher job satisfaction.

3.2 Definitions and Sources

A total of nine indicators are selected to reflect the excellence level of junior secondary education for China and for the world. Data sources of these excellence indicators

Table 1 Data sources of excellence indicators

Excellence indicators	Source (China)	Source (other countries)
1. Total expenditure on junior secondary education per full-time equivalent student	*China statistical yearbook 2020* (MOE, 2021b)	OECD—education at a Glance 2019 (OCED, 2019b)
2. Student–teacher ratio	OECD—Education at a Glance 2019 (OECD, 2019b)	
3. Proportion of teachers fully certified by the appropriate authority	OECD—PISA 2018 (OECD, 2019a)	
4. Repetition rate	UNESCO—Institute for Statistics 2015 (UNESCO, 2015)	
5. Scientific literacy	OECD—PISA 2018 (OECD, 2019a)	
6. Reading literacy	OECD—PISA 2018 (OECD, 2019a)	
7. Mathematical literacy	OECD—PISA 2018 (OECD, 2019a)	
8. Sense of belonging to school	OECD—PISA 2018 (OECD, 2019a)	
9. Teacher job satisfaction	OECD—TALIS 2018 (OECD, 2019c)	

Notes OECD = Organization of Economic Cooperation and Development; UNESCO = United Nations Educational, Scientific and Cultural Organization; PISA = Program of International Student Assessment; TALIS = Teaching and Learning International Survey

are presented in Table 1, and definitions for each of the indicators are also defined below. As seen, OECD has been the primary data source with gaps filled in with other sources (i.e., UNESCO, *China Statistical Yearbook*).

3.2.1 Total Expenditure on Junior Secondary Education Per Full-Time Equivalent Student

This indicator reflects national education input for junior secondary schools, which is calculated by dividing the government total expenditure on junior secondary education by the corresponding full-time equivalent enrollment. Expenditure in national currency is converted into equivalent U.S. dollars (US$) by dividing the national currency figure by the purchasing power parity (PPP) index for GDP. The PPP conversion factor is used because the market exchange rate is affected by many factors (interest rates, trade policies, expectations of economic growth, etc.) that have little to do with current relative domestic purchasing power in different countries. Data for China are retrieved from *China Statistical Yearbook 2020*, and for other countries from OECD-sponsored *Education at a Glance 2019*.

3.2.2 Student–Teacher Ratio

This indicator reflects education input for junior secondary schools, which refers to the ratio of students to teaching staff. Data for both China and for other countries are retrieved from OECD-sponsored Education at a Glance 2019.

3.2.3 Proportion of Teachers Fully Certified by the Appropriate Authority

This indicator reflects education input for junior secondary schools, which refers to the ratio of teachers who have the required credentials to teach in junior secondary schools. Data for both China and for other countries are retrieved from OECD-sponsored PISA 2018.

3.2.4 Student Repetition Rate

This indicator reflects education output from the perspective of students, which refers to the proportion of students from a cohort enrolled in a given grade at a given school year who study in the same grade in the following school year. Ideally repetition rate should approach 0%. High repetition rate reveals problems in the internal efficiency of the education system and possibly reflect a poor level of instruction. Data for China and for other countries are retrieved from UNESCO Institute for Statistics (UIS) (2015).

3.2.5 Student Scientific Literacy

This indicator reflects education output from the perspective of students. Data for both China and other countries are retrieved from OECD-sponsored PISA 2018. In PISA 2018, scientific literacy refers to students' ability to "explain phenomena scientifically, evaluate and design scientific inquiry, interpret data and evidence scientifically" (OECD, 2019a).

3.2.6 Student Reading Literacy

This indicator reflects education output from the perspective of students. Data for China and for other countries are retrieved from OECD-sponsored PISA 2018. In PISA 2018, reading literacy refers to students' ability to "understand and use those written language forms required by society and/or valued by the individual" (OECD, 2019a). Readers can construct meaning from texts in a variety of forms. They read to learn, to participate in communities of readers in school and everyday life, and for enjoyment.

3.2.7 Student Mathematical Literacy

This indicator reflects education output from the perspective of students. Data for China and for other countries are retrieved from OECD-sponsored PISA 2018. In PISA 2018, mathematical literacy refers to students' ability to "formulate, employ and interpret math in a variety of contexts" (OECD, 2019a). It includes "reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena" (OECD, 2019a). It assists individuals to recognize the role that math plays in the world and to make the well-founded judgements and decisions needed by constructive, engaged, and reflective citizens.

3.2.8 Student Sense of Belonging to School

This indicator reflects education output from the perspective of students, which refers to students' feelings of being accepted and valued by their peers and by others at school. Data for both China and for other countries are retrieved from OECD-sponsored PISA 2018.

3.2.9 Teachers' Job Satisfaction

This indicator reflects education output from the perspective of teachers, which refers to teachers' overall evaluation of being a teacher at a school, such as the sense of fulfilment and gratification that they get from the work. Data for China and for other countries are retrieved from OECD-sponsored TALIS 2018.

3.3 Findings

3.3.1 Raw Data Results

The raw means of the nine excellence indicators for the eight countries are presented in Table 2.

As seen in Table 2, the total expenditure on junior secondary education per full-time equivalent student ranges from US$3,942 to US$14,249 across the eight countries. Obviously, the total expenditure per student in China is much lower than that of developed countries. Student–teacher ratio ranges from 12.59 to 16.18 across the eight countries. China has the lowest student–teacher ratio compared with the developed countries. The lower student-to-teacher ratio may indicate more opportunities for one-on-one time with students so that their learning challenges can be identified early, and effective measures can be implemented quickly. Lower student-to-teacher ratio may also lead to better relationships between teachers and students, and lower behavior problems and disruptions. Teachers of smaller classrooms spend less time

Table 2 The raw means of excellence indicators, by country

	Raw means for countries							
	China	U.S	Denmark	France	U.K	Japan	ROK	Netherlands
1. Total expenditure on junior secondary education per full-time equivalent student (in thousands)	3.94	14.14	12.56	11.44	12.20	10.79	13.78	14.25
2. Student–teacher ratio	12.59	15.19	12.93	14.47	16.18	12.86	13.02	16.02
3. Proportion of teachers fully certified by the appropriate authority	96.20	92.60	87.80	74.80	95.60	95.90	94.50	86.60
4. Repetition rate	0.03	1.78	2.60	1.25	N/A	N/A	0.01	N/A
5. Scientific literacy	590	502	503	493	505	529	519	503
6. Reading literacy	555	505	498	493	504	504	514	485
7. Mathematical literacy	591	478	500	495	502	527	526	519
8. Sense of belonging to school	−0.19	−0.24	0.28	−0.07	−0.19	0.02	0.28	0.20
9. Teacher job satisfaction	90.50	89.60	N/A	84.70	N/A	81.80	89.10	93.90

Notes

1. N/A means that the data for the specific country are not available. The unit measure of total expenditure on junior secondary education per full-time equivalence student is equivalent US$ using Purchasing Power Parity (PPP)

on discipline and classroom management. This leaves more time for building a meaningful relationship with each student, as well as actual teaching. The proportion of teachers certified by the appropriate authority ranges from 74.80 to 96.20% across the countries. In particular, China has the highest proportion of teachers certified by the appropriate authority. Student repetition rate for all the eight countries remains at a relatively low level (<5%). As for scientific, mathematical, and reading literacy, students from the Asian countries (i.e., Japan, ROK, China) tend to have better achievements than their western counterparts (i.e., the U.S., the U.K., Germany, France, the Netherlands). In particular, China ranks the top among all the selected countries. Students' sense of belonging to school ranges from −0.24 to 0.28 across the countries. The mean score of China is −0.19 (<0), which is lower than the average score of the OECD countries. The level of teachers' job satisfaction ranges from 81.80 points to 93.90 points across the countries. The job satisfaction of teachers in China remains at a relatively high level (index score was 90.50), as compared to those from other countries. In fact, job satisfaction plays an essential role in the overall commitment and productivity of the school organization. The more satisfied teachers are with their jobs, the better their participation and commitment to the school would be.

3.4 Transformed Data Results

As seen above, the unit and scale of the nine excellence indicators are different, and thus it may be hard to make international comparison among the countries as a whole. In order to facilitate comparison, the raw data have been transformed in this section using the following method: the country with the highest mean value in a specific variable would be assigned a score of 100, and the score allotted to other countries would be based on the raw score ratio between the specific country and the country with the highest value. For example, China was assigned a transformed score of 100 on mathematical literacy because its raw score was the highest (with a raw score of 591 points). The raw score of the U.S. was 478 points. The ratio between China and the U.S. was 1: 0.8088, and thus the transformed score for the U.S. was 80.88. The above data transformation method has been applied for eight out of the nine indicators in this section except for student repetition rate. The repetition rate for all of the eight countries is at a relatively low level (<5), thus all the countries were given a score of 100 on this indicator. The transformed data results are presented in Table 3.

3.5 Discussion

China has shown both strengths and weaknesses in junior secondary education when compared with developed countries. From the perspective of education input, the total expenditure on junior secondary education per equivalent full-time student in China is much lower than that of the other countries. This result seems to be reasonable because China is still a developing country. However, China has the highest proportion of teachers fully certified by the appropriate authority, and student–teacher ratio was the lowest among the selected countries. This seems to reflect that China has put great emphasis on the qualification and professionalization of teachers to ensure education quality. From the perspective of education output, the repetition rate in China is low, and Chinese students tend to excel in scientific, mathematical, and

Table 3 The transformed means of excellence indicators, by country

	Transformed means for countries							
	China	U.S	Denmark	France	U.K	Japan	ROK	Netherlands
1. Total expenditure on junior secondary education per full-time equivalent student	27.67	99.22	88.15	80.27	85.61	75.70	96.67	100
2. Student–teacher ratio	100	79.40	97.37	85.13	71.52	97.93	96.60	75.67
3. Proportion of teachers fully certified by the appropriate authority	100	96.26	91.27	77.75	99.38	99.69	98.23	90.02
4. Repetition rate	100	80.88	84.60	83.76	84.94	89.17	89.00	87.82
5. Scientific literacy	100	90.99	89.73	88.83	90.81	90.81	92.61	87.39
6. Reading literacy	100	85.08	85.25	83.56	85.59	89.67	87.97	85.25
7. Mathematical literacy	100	100	100	100	N/A	N/A	100	N/A
8. Sense of belonging to school	−67.86	−85.71	100	−25.00	−67.86	7.14	100	71.43
9. Teacher job satisfaction	96.38	95.42	N/A	90.20	N/A	87.11	94.89	100

Notes N/A means that the data for the specific country are not available

reading literacy compared with other countries. However, some of student social-emotional development (i.e., sense of belonging to school) may still need to be improved. Moreover, teachers' job satisfaction is at a relatively high level.

4 Best Practices

*4.1 Promoting Well-Rounded Education (*Suzhi *Education) Through Assessment Reform*

Assessment reform plays an important role in promoting a country's education quality. In China, one of the most important assessments for junior secondary school students is the high school entrance examination, which is commonly held at the end of June each year by local education authorities. This entrance examination is very important because it determines whether students can enter a senior high school or not. Although most students pass the examination, they must gain high scores in order to be admitted into select high schools and thus receive better education. However, when students fail the examination, students can choose to attend a technical secondary school or vocational school to receive career training, and work as technicians in companies or factories afterwards.

In fact, policymakers, educators, and the public have been discussing reforming the high school entrance examination for a long time. One major concern with the exam is the outcomes-focused nature of the exam that may put students under tremendous pressure from a young age and may overshadow the goal of well-rounded education. To respond to the concern, Chinese government and educational institutions have attempted to deepen reforms of education assessment, proposing different initiatives to transitioning from traditional summative assessment to formative assessment with the purpose of promoting students' holistic development.

For instance, Shanghai of China has proposed and adopted some alternative formative assessments in junior secondary schools. Two primary initiatives are school-based curriculum and Green Academic Evaluation System (Reyes & Tan, 2019).[1] Specifically, schools in Shanghai are given the autonomy to design and launch a series of courses, programs, and activities that meet the diverse needs and interests of students. Together with the new courses, programs, and activities under the school-based curriculum are alternative and formative assessment modes. Students are evaluated based on their daily performance of real-life tasks through experiments, oral presentations, poster displays, and research projects (Shen, 2007; Tan, 2013). Of special mention among the new alternative formative assessment method is the Integrated Quality Appraisal, which is aimed at well-rounded education. This appraisal is intended to evaluate students based on the following aspects: development of moral characters, cultivation of traditional Chinese culture, school courses taken and obtained academic results, innovative spirit and practical ability, physical and mental health and interests and talents (Shanghai Municipal Education Commission, 2014). To ensure reliability and validity, schools are required to objectively record students' growth process and comprehensively reflect their well-rounded development (*ibid*). Unlike outcome-based exams, the Integrated Quality Appraisal is formative as it accumulates the daily and all-round growth and achievement of students

[1] Assessment reforms in high-performing education systems: Shanghai and Singapore.

throughout their learning years. Teachers are expected to track student learning and developmental progress through the Growth Record Booklet by taking note of student moral quality, citizenship quality, learning ability, social interaction and cooperation, and participation in sports, health, and aesthetics (Shanghai Municipal Education Commission, 2006). This appraisal enables students to identify and understand their own strengths and the areas of improvement under the guidance of teachers (Tan, 2013).

Another initiative taken by Shanghai in China to reform education assessment is the Green Academic Evaluation System. This system aims to change the prevailing exam-oriented mindset in Shanghai by focusing not only on student academic performance but also on their physical and mental health as well as moral conduct (Reyes & Tan, 2019). The Green Indices (1.0) included a total of 10 indicators, which were first carried out in 2011 for a total sample size of 63,640 students at the fourth and nineth grades, as well as 9,445 teachers and 804 principals across Shanghai (*ibid*). Later, the indicators were revised in 2018 (Green Indices 2.0), and the revised 10 indicators are as follows:

- Student academic performance index, such as the degree of students meeting the academic standard, student higher-order thinking skills and art literacy
- Student physical and mental health index
- Student moral conduct and social behavior index, such as prosocial behavior, national identity, international perspectives
- Student learning motivation index, such as learning self-confidence
- Student school identity index, such as teacher-student relationship, peer relationship, and sense of school belonging
- Student schoolwork burden and academic pressure index
- Teachers' curriculum leadership index, such as teacher teaching theory, teaching methods and assessment capability
- Principals' curriculum leadership index, such as curriculum plan, curriculum execution and curriculum assessment capability
- Education equity index
- Improvement index.

4.2 Promoting High-Quality and Well-Balanced Education Through Teacher Rotation Program

The imbalanced development of education between urban and rural areas has been perplexing China for a long time. To bridge the current imbalance in education resources between urban and rural schools, MOE along with seven other ministries and governmental departments in China released new guidelines (MOE et al., 2022) in April of 2022, in which more experienced and talented teachers and principals are encouraged to teach students at rural schools. According to the new document, teachers seeking promotion are required to teach at rural or less-developed schools for more than a year, and those who have more than three years of teaching experience at such schools will be preferred in becoming principals. The purpose of the policy is to bring high-quality education resources to more schools in the city. Districts with poor teaching resources can receive better support via methods such as dual-teacher classes during the program. The new policy provides incentives for qualified educators to move, such as higher pay and rotation participation being taken into account when promotion is considered.

Beijing is among the first batches of cities in China to enact this guideline. More specifically, primary and junior secondary school teachers in Beijing's public school system who have worked at the same school for more than six years will be asked to shift to a new school in another district and share their knowledge and experiences with new colleagues and students. Educators who are more than five years away from retirement and have worked at the same school for over six years are qualified for the program. Teachers who have already changed schools identified that the program presents both challenges and opportunities. Li Baoping, an English language teacher at Beijing Huiwen Middle School in Dongcheng district, said "Students from different schools show different characteristics"(Du, 2021). Li transferred to a school in Chaoyang district in September of 2021. "In the process of handling the changes, my abilities in teaching and communication have improved", she said (*ibid*). Lin Ming, the director of Hongshan Branch of Beijing Huiwen Middle School, said that making the participation of the rotation program part of promotion assessments provided a platform for young and middle-aged teachers to develop. Yuan Xin, the mother of a 13-year-old student, said that new teachers at a school introduce fresh teaching methods and stimulate students' interest in learning. "We hope that the policies can reduce children's burden and give them more time to explore what they like," Yuan said. "They can schedule their time better as they grow up" (*ibid*).

Some districts in Beijing have already started to plan and implement the teacher rotation programs. For example, education authorities in Dongcheng district said that all eligible teachers in the district would take part in the rotation program over the next three years. Officials in Miyun district have also announced that they have already arranged for 50 educators to participate in the rotation program in 2022.

4.3 Promoting Education Modernization Through Technology

To greatly bridge education resource gaps between different areas and promote the digitization of education, MOE has launched a smart learning platform covering all stages of education from elementary school to universities on March 28, 2022, to offer free digital learning resources for students (Ma, 2022).

The Smart Education of China (www.smartedu.cn), operated by MOE of China, integrates platforms for primary and secondary school education, vocational education and higher education, and the platform for employment services for college graduates. The platform aims to promote education equality, bridge the digital divide and promote common prosperity with a wide range of education resources and courses. It provides an online classroom for students and teachers who cannot attend in-person courses due to the COVID-19 pandemic.

As of March 28, 2022, the smart learning platform for primary and secondary school students has included around 19,508 courses and 452 textbooks for students at all grades and for all the academic disciplines (Zou, 2022). Moreover, the platform also provides after-school activities, safety education, psychological education, family education and academic research for teachers. All the online courses are recorded by senior teachers at well-known schools and have been refined and improved multiple times. Schools in less developed regions have made good use of the platform, for example, the visits from students in the Guangxi Zhuang Autonomous Region have reached more than 50 million since March 1, 2022, and those from Shaanxi and Gansu Provinces have exceeded 21 million (*ibid*). In addition, all the online courses are accompanied with exercises and quizzes, and students' classroom participation, progress in finishing the exercises can and the scores of the quizzes could be recorded and used by teachers to improve teaching. For higher education, the smart learning platform selected 20,000 high-quality MOOCs in 92 majors and 1,000 higher education courses in multiple languages (*ibid*), so that all people who wish to learn have the opportunity to attend a university online. The platform includes easy-to-use applications and tools tailored to the needs of school students and offers abundant digital resources.

In fact, the launch of the platform, in terms of advancing digitization, serves as a milestone of the education system in China, and it would greatly help bridge the "digital divide" and generate more momentum for the ongoing digital transformation of China's education system. Huai Jinpeng, the Minister of Education, urged local educational departments to promote the use of the platform and to explore other information technology (IT) solutions to help build modern educational infrastructure. He said that a public service system for education digitization would be built as a next step, prioritizing services for students and teachers aimed at a new round of COVID-19 outbreak(*ibid*). In addition, institutional mechanisms need to be strengthened to bring all stakeholders together in setting up this service system. Cooperation and exchanges with the rest of the world will also be necessary.

5 Inspiring Stories

In this section, two inspiring stories for a teacher and a principal at junior secondary schools are introduced. The purpose of this section is to acknowledge the excellence and devotion of Chinese educators and set good examples to individuals who are passionate about education.

5.1 *Zhang Wanbo: Selfless Education Devoter*

Zhang Wanbo is a teacher at the Fifth Middle School in Benxi Manchu Autonomous County of Liaoning Province (MOE, 2021c). He has devoted himself to rural education in a relatively poor region since his graduation in 1997. After gaining a senior title in 2009, he became the head math teacher at his school and began to teach in the nineth grade (also the make-or-break year for completing junior high school) as a class head-teacher. So far, he has won the “National Excellent Teacher”, “National Role Model of Teaching and Educating”, “Benxi Moral Model”, and many other honorary titles.

Zhang loves his students, treating them as his own children. For example, during the time when Zhang was a math teacher, a student in his class was about to drop out of school because of the parents’ divorce. After being aware of the situation, Zhang decided to visit the student’s home and encouraged him by saying “You have me!”. Moreover, he spared some of his limited income with the student, helping him cover basic living expenses. With the great help of Zhang, the student resumed school, and successfully graduated from the middle school after three years of hard work. Another example is that Zhang became a father in 2001. Unfortunately, due to brain hypoxia, his son needed special care in an incubator in the hospital. During that time, Zhang needed to travel almost every day between different counties or towns to get medicine for his son. However, the family emergency did not prevent him from working hard at the school. He persisted to teach math for the nineth grade students, and never asked for leave or even delayed lessons. Moreover, he made use of after-class time to help students improve without asking for any compensation. At the end of the semester, the academic excellence rate of his class ranked in the top third in the county, and the overall performance of the students was even better than those from the middle schools in the town.

Zhang has also been a keynote speaker at many forums on educational ethics and pedagogy, actively sharing effective teaching practices for schools in rural areas. For example, he suggested to keep a notebook to write down all the wrong answers students give in mathematical exams and exercises which turned out to be effective in improving student math performance. This method has now received wide recognition from experts in the field of education and has now been promoted in the entire school. Moreover, he also explored and proposed a new teaching mode specifically suitable for rural students, and gradually formulated his own teaching style. These valuable experiences have been summarized and published in the book *Practice – Seeking Teachers’ Professional Happiness* and *Excellent Teacher Growth Cases and Class Documentation.*

5.2 Feng Enhong: Brave Education Innovator

Feng Enhong is the founder and principal of Shanghai Jianping High School (Xiaozhangwang, 2013). He also holds important roles in other professional institutes and government organizations. He has been dedicated to the reform of Chinese basic education system, as well as the social and individualized development of students. So far, he has been awarded as "Superior-grade Teacher in Shanghai", "National Model Worker", "National Model Head Teacher", and many other honorary titles.

Feng is an innovative teacher, and he has been striving to reform the traditional teaching modes. For example, he realized that traditional moral education in China might be old-fashioned, so he explored and created a new way to implement moral education. Specifically, he abandoned the traditional way of lecturing and infused moral education into almost every aspect of student life. For example, he guided students to watch the classic movie *Red and Black* and encouraged students to express their thoughts and justify their ideas and opinions. He also helped students feel the collective power and the happiness of serving others by organizing the whole class to celebrate birthdays for specific students. In addition, teachers tend to put great emphasis on student mastery of knowledge rather than fostering the independent thinking ability. In light of the above issues, he proposed that there are three basic elements of a course: question, collaboration, and appropriateness (Sohu, 2020), and suggested that after delving into the textbooks, teachers should pay more attention to students' ability to raise questions and collaborate with others, and meanwhile the idea of stratified teaching and zone of proximal development should also be employed while teaching.

Feng is also an innovative principal, and he has proposed two general principles to cultivate students, that is, "Standard plus Choice" and "Qualification plus Specialty". To be more specific, "Qualification plus Specialty" means that educators need to bear in mind that every student has the potential to perform well, but they may vary in individual interests. The goal of education is to educate and equip students with diversified skills based on the requirement of the society. Educators need to adhere to the laws of student physical and mental development, try to tap students' full potential, and arouse their interests to the greatest extent. To facilitate the idea of "Qualification plus Specialty", many high-quality required and elective courses have been opened in Shanghai Jianping High School, such as math Olympic competition, driving, weaving, photographing, computer multimedia technology, calligraphy, sculpture, and chess. In addition, various extracurricular activities have also been organized to develop students' interests. For example, one of the grandest school activities is the Art Festival. At the festival, students can make full use of creativity and initiative to design interesting activities, such as hot-air balloon, culinary experiences, as well as music and dance performances.

As for the idea of "Standard plus Choice", it means that there should be clear and detailed regulations or rules to manage the school, which cover the responsibilities of the principal even to school sanitary work. Meanwhile, the school should provide diversified choices such as in course selection and in many other areas. For example, Shanghai Jianping High School has set up many school-based courses in addition to the national required courses, and various student clubs have been organized to enrich student school life. The successful experience of Shanghai Jianping High School has subsequently been propagated to the whole country, and relevant school management material has been translated to English and produced international impacts as a result. In 2003, a television drama called "It is Rich in Golden Apple" has been broadcasted in China, which has taken Feng as a prototype and depicts the story of education reform in China.

6 Latest Research

In this section, latest research in the field of junior secondary education is summarized. The purpose of this section is to present the current research focuses of Chinese junior secondary education.

6.1 An Overview of Research on Junior Secondary Education in China

Using "junior secondary education" as the keyword, the latest 10-year Chinese Social Science Citation Index (CSSCI) journal papers (2012–2022) are searched in the China National Knowledge Infrastructure (CNKI) website. The distribution of the most studied topics related to junior secondary education is presented in Fig. 13.

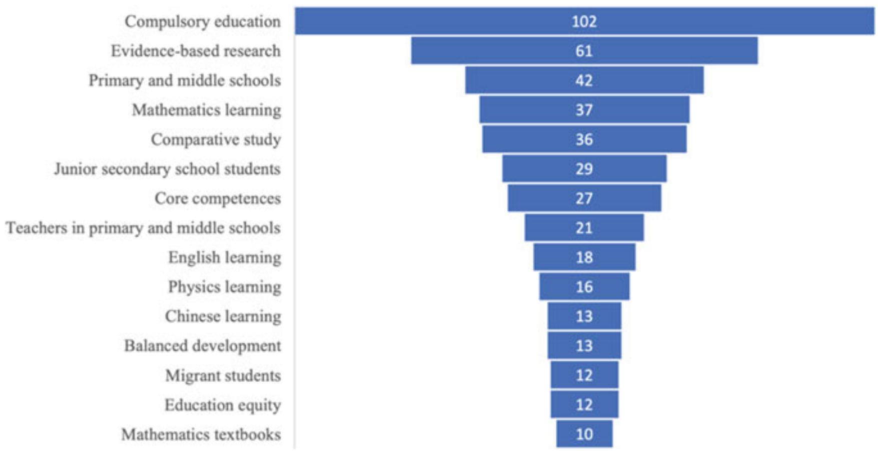

Fig. 13 Recent topics in CSSCI journals on junior secondary education (2012–2022). *Source* Compiled from search results in CNKI

As seen in Fig. 13, the most studied topic related to junior secondary education is compulsory education (with 102 CSSCI journal papers from 2012 to 2022), followed by topics featured by evidence-based research (with 61 journal papers), primary and middle schools (with 42 journal papers), math learning (with 37 journal papers), comparative study (with 36 journal papers), junior secondary education students (with 29 journal papers), core competencies (with 27 journal papers), teachers in primary and middle schools (with 21 journal papers), English language learning (with 18 journal papers), physics learning (with 16 journal papers), Chinese language arts learning (with 13 journal papers), balanced development (with 13 journal papers), migrant students (with 12 journal papers), education equity (with 12 journal papers) and math textbooks (with 10 journal papers).

From the distribution of the topics, evidence-based research is receiving increasing attention in the field of Chinese language arts education over the past decade. In addition, these topics can roughly be summarized into three broad categories: school subject teaching and learning (i.e., math learning, English language learning, physics learning, and Chinese language arts learning); balanced development of junior secondary education (i.e., education equity, migrant children); and student core competencies. Additional information about each of these categories/areas is provided below.

6.2 *Research on School Subject Teaching and Learning*

One of the most studied topics around junior secondary education of China is school subject teaching and learning, which deals with topics related to exploring general rules and efficient ways for educators to impart subject-related knowledge for students to better understand subject matter and foster core competencies, as well as for designing and analyzing textbooks and curriculum standards (i.e., Zhang & Hu, 2022; Gu & Zhang, 2021; Wang, 2020).

For instance, Lin et al. (2021) conducted an experimental study to explore the effect of mind mapping on junior secondary school students' Chinese language arts learning and creative thinking. Results indicate that four-month mind map (i.e., diagrams to help visualize thoughts and communicate them to others) training could significantly improve student Chinese language arts learning interest and creative thinking skills. Wu and Zhang (2019) examined the effect of math writing (i.e., writing down the understanding of math concepts, and recording the problem-solving processes) on math performance among Chinese minority middle school students. Results suggest that math writing could significantly improve student math performance, as well as their math learning motivation. Wang (2020) found that collectivism in textbooks has undergone dramatic changes since the reform and opening-up in China by analyzing the protagonists in Chinese language arts textbooks, and there exists a complex relationship between collectivism and the individualization of the society. To fully optimize textbooks, education should pay more attention to the value of collectivism in resolving inherent dilemma of individualized society and reconstruct collectivism in textbooks.

6.3 Research on Balanced Development of Junior Secondary Education

Recent years have witnessed an increasing number of journal papers focusing on the balanced development of junior secondary education, including such topics as comparing educational resources between rural and urban areas, as well as employing technology to narrow down the gap between different areas.

For instance, Liu (2014) discussed the effect of IT on the balanced development of regional education from five aspects: construction of IT environment, education resource construction, application of IT teaching, teachers' professional development and students' information literacy training. Zhang, Sheng, and Luo (2019) reviewed China's history of reform and opening-up, and they found that the balanced development of China's compulsory education has experienced great changes, from "unbalanced development" to "basic balanced development", and then to the goal of "quality and balanced development". In fact, the development of compulsory education in China has made outstanding achievements over the years, as demonstrated in the increasing funding, the qualification of teaching staff, and better conditions for running schools. Meanwhile, the educational gap between urban and rural areas has been significantly narrowed.

Moreover, researchers have also paid special attention to improving the compulsory education of special groups of students including left-behind children (i.e., parents working in the city, while children are left behind in rural areas) and for migrant children. For example, Duan et al. (2020) investigated the effect of parents' working from countryside to city on left-behind children's compulsory education using the data from the China Family Panel Studies (CFPS). The propensity score indicated that parents' working from countryside to city had a negative impact on children's academic performance. Researchers argued that the negative impact might occur because parents who work from countryside to city may not value education as much as those who do not work from countryside to city. Moreover, left-behind children might have fewer opportunities to attend extra-curricular lessons, and they might be distracted by the use of phones more easily.

Zhang (2015) discussed the equalization of migrant children's school education based on the perspective of Hermeneutics. The researcher pointed out that problems existed in the current equalization of migrant children's school education, such as promoting educational equity for migrant children to financially supporting, assimilation, or educational welfare, which impeded the realization of substantial educational parity. To promote migrant children's school education from the perspective of Hermeneutics, communication between rural and urban groups and the realization of mutual understanding and self-identification is important. Such interactions are socialized, equal, critical and reflective, mutually beneficial, and emotion based. The realization of the equalization demands the reforms in the construction of school culture, the establishment of school norms, the development of school-based curriculum, and the innovation in evaluation system.

6.4 Research on Fostering Core Competencies for Student Success

Fostering core competencies of junior secondary school students has been an important hot topic over the past several years. Related research topics include comprehensive quality assessment, and senior high school entrance examination reform.

For example, Liu and Li (2021) identified some potential issues or problems of student evaluation of comprehensive practical activities in primary and junior secondary schools. They suggested that educators should pay more attention to selective evaluation rather than promoting evaluation, to unified evaluation rather than individualized evaluation, to teacher evaluation rather than diversified evaluation, to quantitative evaluation rather than qualitative evaluation, to routine work rather than normal evaluation. Feng et al. (2022) proposed the idea of assessing student comprehensive skills using big data analytical techniques. Specifically, they suggested that the comprehensive quality assessment should evaluate student from diverse aspects such as physical health, mental health, moral characteristics, scientific literacy and humanity literacy. In order to achieve accurate assessment, educators should collect relevant data from teachers, peers, parents and students themselves, and establish individual development profile for each student. This profile would record student learning progress and growth, and help teachers design and implement more adaptive and individualized instruction.

7 National Policies

In this section, some basic and recent national policies about junior secondary education in China are introduced, with the purpose of providing detailed information about junior secondary education in China from the policy perspective. It is worth noting that these policies are stated and organized into themes in this section, in order to promote a better understanding of the policies.

7.1 Policy Development on Junior Secondary Education in China

One major goal of junior secondary education is to nurture children so that they will become adults with well-rounded abilities, not just people who can achieve high test scores. In order to promote holistic development, Chinese government has issued a series of relevant guidelines or policies over the past 30 years. These policies are primarily focused on two important aspects: fostering student core competencies that help them be better prepared for the future world; and relieving student academic burden to make room for their well-rounded development. Below some basic education policies around these two aspects are summarized.

7.1.1 Fostering Student Core Competencies

In 1999, the Third National Education Work Conference themed "Deepen Educational Reform, Promote Well-Rounded Development" was held in Beijing. At the same year, *Decisions on Deepening Educational Reform and Promoting Well-Rounded Education* was issued (The State Council, 1999), stipulating the goal and the essence of China's well-rounded education, as well as the specific measures that could be taken to guarantee the implementation of the policy, which marked the beginning of China's well-rounded education.

In 2006, the *Compulsory Education Law of the People's Republic of China* was amended, in which well-rounded education was first highlighted at the country's level (National People's Congress, 2006). According to the law, the national policy on education shall be implemented and well-rounded education shall be carried out in compulsory education to improve the quality of education and enable children and adolescents to achieve well-rounded development—morally, intellectually, and physically—so as to lay the foundation for cultivating well-educated and self-disciplined builders of socialism with high ideals and moral integrity. In addition, the educational and teaching work shall be in line with the education rules and the characteristics of the physical and mental development of students, be geared to all students, impart knowledge and enlighten people, integrate moral education, intellectual education, physical education and aesthetic education in the educational and teaching activities. Moreover, it should focus on the cultivation of the students' independent thinking skills, creativity, and practical skills so as to promote the well-rounded development of students.

In 2010, the *Outline of the National Plan for Medium- and Long-term Education Reform and Development (2010–2020)* (The State Council, 2010) was issued, further stipulating that education shall promote student well-rounded development. The *Outline* specified that moral education, intellectual education, physical education, and aesthetic education shall be stepped up and improved in an all-round way. It is imperative to give equal footings to cultural learning and moral edification, to theoretical study and social practice, and to well-rounded education and individual characteristics. Great importance should be attached to physical health. Students' physical education courses and time for extracurricular activities must be guaranteed and the quality of physical education must be improved. In the meantime, fine education in mental health shall be provided to improve students' mental and physical health. Education in aesthetics shall be intensified to instill a cultured aesthetical taste and enhance their cultural attainment. Labor education should be strengthened to cultivate their love for work and the working people.

In 2016, MOE put forward the concept of student core competencies. At the same year, the *Core Competencies and Values for Chinese Students' Development* (People's Daily, 2019) was released, which was an iconic event in the well-rounded education field. Policies attach more importance to students' comprehensive competencies instead of test scores, and MOE proposed that tests of students' aesthetic abilities will be added to the senior high school exams in 2022.

In June of 2019, the *Guidelines on Deepening the Reform of Education and Teaching and Comprehensively Improving the Quality of Compulsory Education* was issued. The *Guidelines* aim to develop an education system that foster citizens with an all-round moral, intellectual, physical, and aesthetic grounding, in addition to a hard-working spirit, according to the document. The key points of the *Guidelines* include:

- According to the *Guidelines*, compulsory education should emphasize the effectiveness of moral education with emphasis on cultivating ideals and faith, core socialist values, China's excellent traditional culture, ecological civilization, and mental health.
- The *Guidelines* stresses elevating intellectual grounding level to develop the cognitive ability and the sense of innovation of the students.
- The *Guidelines* also calls for strengthening physical education, enhancing aesthetic training with more art curriculums and activities, and encouraging students to participate in more physical work to boost their hard-working spirit (The State Council, 2019).

7.2 Relieving Students' Academic Burden

Compared to other countries, the academic pressure of Chinese students is relatively intense. According to statistics, the market share for private tutoring in China exceeded eighty million in 2020, and over 13.70 million elementary and middle school students attended private tutoring activities (Sina, 2020). In order to reduce student academic workload, the government released the *Guidelines on Further Easing the Burdens of Excessive Homework and Off-Campus Tutoring for Students Undergoing Compulsory Education* (the "Double Reduction" policy) on July 24, 2021 (The State Council, 2021). The *Guidelines* took immediate effect on the day of its release.

"Double Reduction" in the *Guidelines* refers to a reduction in the total amount and time of commitment required by school homework and a reduction in the burden of off-campus or after-school training programs. Based on the *Guidelines*, the "Double Reduction" policy is intended to improve the overall quality of school education, reduce excessive study burdens, and protect the health of students, relieve the burdens and anxiety of parents, reduce social inequity, further regulate and standardize off-campus training (including both online and off-line training), and strictly implement the *Compulsory Education Law*, the *Protection of Minors Law* and other laws and regulations governing the education industry.

While the *Guidelines* set out various goals and requirements for in-school education, particular emphasis is placed on regulating after-school private tutoring activities. Some key points in the document include (Ross et al., 2021):

- New subject-based off-campus and after-school training institutions targeting compulsory education students will not be approved by local authorities.
- All existing subject-based off-campus training institutions will be required to convert to or register as "non-profit organizations".
- All online subject-based training institutions will be required to obtain approval from the local government.
- For non-subject-based training institutions (i.e., sports, art, music programs), local governments should clarify the corresponding departments in-charge, formulate standards by subject area, and implement a strict review and approval regime.
- All subject-based training institutions are prohibited from conducting Initial Public Offerings (IPOs) or otherwise raising funds from capital markets.
- Public companies are prohibited from investing in any subject-based training institutions through stock market financial transactions or acquisitions of assets from such institutions in the form of equity or cash.
- Foreign capital is prohibited from engaging in mergers or acquisitions, trustee arrangements, franchising, or using "Variable Interest Entity" (VIE) structures to control or participate in subject-based training institutions.
- Content review—a filing and supervision system will be established to control and monitor training materials and training content.
- Excessive training and early education are prohibited. Non-subject-based training institutions are prohibited from engaging in subject-based training or providing overseas education courses.
- Off-campus training institutions are prohibited from using national holidays, weekends or winter or summer breaks to organize subject-based training programs.
- Training institutions are prohibited from enticing teachers away from public schools through improper means. Advertisements for training institutions are banned on mainstream media platforms.
- Financing activities and capital injections into training institutions will be further regulated.
- Some more developed cities such as Beijing, Shanghai and Guangzhou will launch pilot programs to re-examine existing "subject-based" training institutions; offer

in-school extracurricular programs by using school resources or inviting off-campus training institutions through a government-led selection process; and strengthen the regulation of training fees/charges.

The "Double Reduction" policy will bring a fundamental change to the landscape of China's compulsory education, which aims to address the most prominent problems in compulsory education, that is, the excessive academic burden on primary and middle school students, and the off campus tutoring that overloads parents financially and mentally, and seriously hedged the outcomes of education reform. MOE and local education authorities in different localities are in the process of formulating detailed rules to implement the "Double Reduction" policy.

In addition to the "Double Reduction" policy, Chinese government has also issued a set of additional guidelines to ease student excessive workload. For example, on August 30, 2021, MOE issued a notice criticizing the high frequency and difficulty of exams and emphasis placed on test results, which harms the body and minds of students (MOE, 2021d). The amount of testing and homework has since been reduced in primary and middle schools, while measures have been taken to prevent test scores from being published and ranked. After-school services in public schools are being extended to support working parents, non-curriculum training sectors such as in the arts and sports are expanding, and new commitments to increase teachers' salaries in public schools have been made.

Moreover, Chinese lawmakers have adopted a new law on family education promotion at a session of the National People's Congress Standing Committee on October 23 of 2021. The *Family Education Promotion Law of the People's Republic of China* (National People's Congress, 2021) stipulates that parents or other guardian of the minors shall be responsible for family education, while the state, schools and society provide guidance, support, and services for family education. In response to the country's drive to relieve academic workload of young students, the law requires local governments at or above the country level to take effective measures to reduce the burden of excessive homework and off-campus tutoring in compulsory education. The law bans parents from placing an excessive academic burden on their children, stating guardians of the minors should appropriately organize children's time for study, rest, recreation, and physical exercise. Parents are also required to play their part in preventing their children from being addicted to the internet. Pinning high hopes on their children, many Chinese parents would bend over backward to help their kids succeed. They are willing to fork out RMB200 (about US$31) or more for a 45 min tutoring class to help children score high in tests(Xinhua, 2021b). Weighed down by workload, Chinese students are facing increasing incidence of myopia, more sleep deprivation and poor fitness that worry many.

7.3 Current Policy Highlights

Like many other countries, China has been grappling with providing equal educational resources to all students in recent years. Due to the long-standing urban–rural divide, schools in rural areas of China have significantly lagged their urban counterparts in many aspects, such as in school conditions, teaching workforce, and student academic performance. The Chinese central government has thus enacted a series of national and regional policies to deal with the urban–rural disparities. The policy on teacher rotation program is a recent example of such policy endeavors.

The teacher rotation program was initially proposed and implemented in large business corporates with the purpose of encouraging employers to step out of their comfort zones and to acquire new knowledge and skills from others. In the field of education, the rotation program was first introduced for teachers by Chinese government in 1996 as a way to promote the balanced development of compulsory education, and it was officially written in the amended *Compulsory Education Law of the People's Republic of China* in 2006. Later, many different counties or districts in China began to pilot the teacher rotation program. For example, the total number of teachers participated in the rotation program in Wuhan province has reached 150,000 in 2020 since its first implementation in 2015 (Sina, 2021).

In August of 2014, MOE, together with other ministries jointly issued *The Guidelines on Promoting Teacher Rotation in Compulsory Education Schools*(Zhao, 2014). According to the *Guidelines*, no less than 10% of teachers in urban and high-quality schools should be rotated to teach in rural and poor schools each year. To prevent schools from sending less qualified teachers to rural schools, the policy requires at least 20% of the rotated teachers to be high-quality teachers. The policy also requires principals and deputy principals to be rotated to a different school after two terms of service in the same school. Teachers from rural schools and poor schools will have the opportunity to fill the vacated positions in urban schools and better-quality schools.

In fact, there are very few details about how the teacher rotation program should be executed in the national policy documents, leaving the autonomy to local governments at various levels. As seen from the current local government policies, the duration of the rotation program is typically two to three years for teachers and one term (typically three to six years) of service for principals. Teachers and school leaders would return to their original school afterwards. In some cases, teachers may be transferred to another school. The rotation is among schools within the same administrative district or county. There are a variety of enticements and requirements to encourage participation, such as cash bonuses, priority and or prerequisite for promotion, and housing privileges.

In response to the teacher rotation policy, the Shanghai Municipal Education Commission issued the *Guidelines of Strengthening the Construction of Teachers' Personnel Management System* in January of 2021, in which the teacher rotation program has been added to the agenda. In August of 2021, the Beijing Municipal

Education Committee also declared to promote the teacher rotation program on a large scale and released the detailed implementation specifications.

8 Summary

This chapter provides an overview of the junior secondary education (middle school) of China. Over the past decades, Chinese government has issued a series of national and/or regional policies to meet current and anticipated future needs and challenges as the world is becoming more globalized and diverse, and great achievements have been made in improving the quality of the junior secondary education, particularly in eliminating illiterates, decreasing drop-out rates, and strengthening education equity. Moreover, a number of good education practices and inspiring stories emerged, which have become the most valuable assets in the development of China's education cause.

From an international comparison perspective, results from international large-scale assessment indicate that Chinese students tend to excel in academic literacy (i.e., math, reading, science), and the qualification of teachers in junior secondary schools are also at a satisfactory level. However, the academic burden (i.e., total learning time per week) of Chinese junior secondary school students are still heavy, and there is still room to promote the development of student noncognitive skills.

However, it should be noted that the results in this chapter, particularly for the Highlighting Data section and the Excellence Indicators section, are primarily based on data retrieved from the international large-scale assessments such as PISA 2018 and TALIS 2018. The students/teachers in each country are only stratified samples selected from the whole country. Hence, the results' generalizability is limited to certain extent. Moreover, some data (i.e., fear of failure, teacher self-efficacy) may suffer from self-report bias.

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Chapter 4
Secondary Education (High School) in China

Wang Shuai, Li Xin, and Shen Siqi

Abstract Secondary education (high school) is an important link between compulsory education and higher education. This chapter demonstrates education data obtained from OECD, UNESCO, the official website of the Ministry of Education of China (MOE), and other data sources, and conduct analysis based on these data. The results show that due to a large population, China has a certain disadvantage when compared with developed countries in terms of total expenditure per full-time equivalent student. Despite this added hurdle, China has reached or surpassed the global average in multiple measures, including student–teacher ratio and teacher attrition rate. This chapter also preliminarily constructs three dimensions of indicators (input, output, and college preparation) to examine excellent high schools in international context. Additionally, this chapter analyzes the development trends of China's high school education from the perspectives of latest research and national policies, and presents aspirational stories and best practices. The chapter provides readers with a unique lens to understand the current and future development of China's high school education in the international context.

Keywords High School education · Curriculum reform · College entrance exam reform · Core competency · Moral education · Well-rounded education · Student development

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1 Introduction

High school education is an important part of the national education system. High school education, which is between basic education and post-secondary education, has a significant impact on student development (*rencai peiyang*). Not only does high school education influence higher education, but it also directly impacts social capital. According to OECD (2021a), a high school education "has become a minimum requirement for navigating the modern economy and society". The popularity and quality of high school education directly impacts social capital which further affects national development. Chinese government places a high value on the cause of high school education and has integrated high school education development into the national strategic development system. With strong national support, China's high schools continue to improve teaching conditions, develop educational resources, and improve education quality aiming to cultivate talents with overall quality and excellence. It is worth noting that 2022 marks the 10th anniversary of high school education reform, which began from the 18th National Congress of the Communist Party of China (CPC) in 2012. In the past decade, China's high school education has made important progress and remarkable achievements (see Table 1).

The data above show that China's high school education has improved significantly in popularity, financial investment, teaching conditions, and teacher resources.

However, scholars across the globe may not be aware of the latest changes in high school education in China. Some scholars may still hold onto outdated perceptions and past criticisms of China's education. For instance, Xu Guanlin, the honorary president of Nanyang Technological University in Singapore, has criticized China's

Table 1 Achievements of high school education reform in China over the past decade

Aspects	Indicators	Data (2012)	Data (2021)	Changes
Universal access to education	Number of high schools	13,509	14,600	↑ 8%
	Gross enrollment ratio	85%	91.4%	↑ 6.4%
Financial investment	Fiscal expenditure of education (RMB100 million)	2,317	4,666	↑ 101%
Teaching conditions	Instrument and equipment value per student (RMB)	2,127	4,968	↑ 134%
	Area of school buildings (km^2)	420	644	↑ 52.35%
	Proportion of large classes	47.76%	4.81%	↓ 42.95%
Teacher resources	Number of full-time teachers	1,595,000	2,028,300	↑ 27.17%
	Student–teacher ratio	15.47:1	12.84:1	↓ 20.48%
	Percentage of teachers with a bachelor's degree or higher	96.44%	98.82%	↑ 2.38%
	Percentage of teachers with a master's degree or higher	5%	12.4%	↑ 148%

Source MOE (2022)

high school education for placing too much emphasis on examinations and test scores (Zhang, 2012). Education scholars from different countries have condemned China's exam-oriented culture for impeding creative education (Mullen, 2017). However, with the advancement of education reforms in China, China's high school education is not what it used to be.

This chapter aims to introduce the new developments of China's high school education systematically, and from an international perspective. This chapter intends to help international researchers better understand China's high school education, and thus promote educational communications between China and other countries. Furthermore, successful experiences of China's education will be highlighted, promoting the common development of educational causes across the globe.

2 Highlighting Data

This section analyzes the resources invested in education in China and other countries, including human resources (e.g., teachers), financial resources, and physical resources (e.g., facilities). The resources to be compared are shown in Table 2. The data are mainly drawn from OECD's annual *Education at a Glance* report and UNESCO databases. While indicators for China are not directly available in the datasets of OECD and UNESCO, this chapter calculates comparable indicators using data from China's Ministry of Education (MOE), National Bureau of Statistics and other authorities.

2.1 Student–Teacher Ratio

The ratio of students per teacher is calculated by comparing the number of full-time equivalent students at a specific education level to the number of full-time equivalent teachers directly involved in teaching at the same level of education (OECD, 2022a).

Table 2 An overview of the indicators in highlighting data

Type of resources	Indicators
Human resources	Student–teacher ratio
	Percentage of teachers qualified according to national standards
	Percentage of teachers with a bachelor's degree or higher
	Teacher attrition rate
Financial resources	Total expenditure per full-time equivalent student (PPPs for GDP)
	Total expenditure on educational institutions as a percentage of GDP
Physical resources	Proportion of schools with access to internet

As a measure of teaching resource allocation, the student–teacher ratio is considered to be a determining factor of learning outcomes and a significant indicator of educational quality (OECD, 2013; UNESCO, 2022a). Studies find that the lower the student–teacher ratio is, the more support and attention students are likely to receive (Biddle & Berliner, 2002) and the higher academic performance students may achieve. An empirical study based on PISA 2009 finds that poor academic performance may result from a high student–teacher ratio (Hou & Shen, 2014).

According to OECD, in 2019, among the OECD countries with available data, the ratio of students to teaching staff at high school level in general programs varies from 9:1 in Latvia and Lithuania to 28:1 in Mexico, with an average of 13:1. In China, the average student–teacher ratio in regular senior secondary schools is 12.99:1, which is roughly equal to the average in OECD countries (Fig. 1).

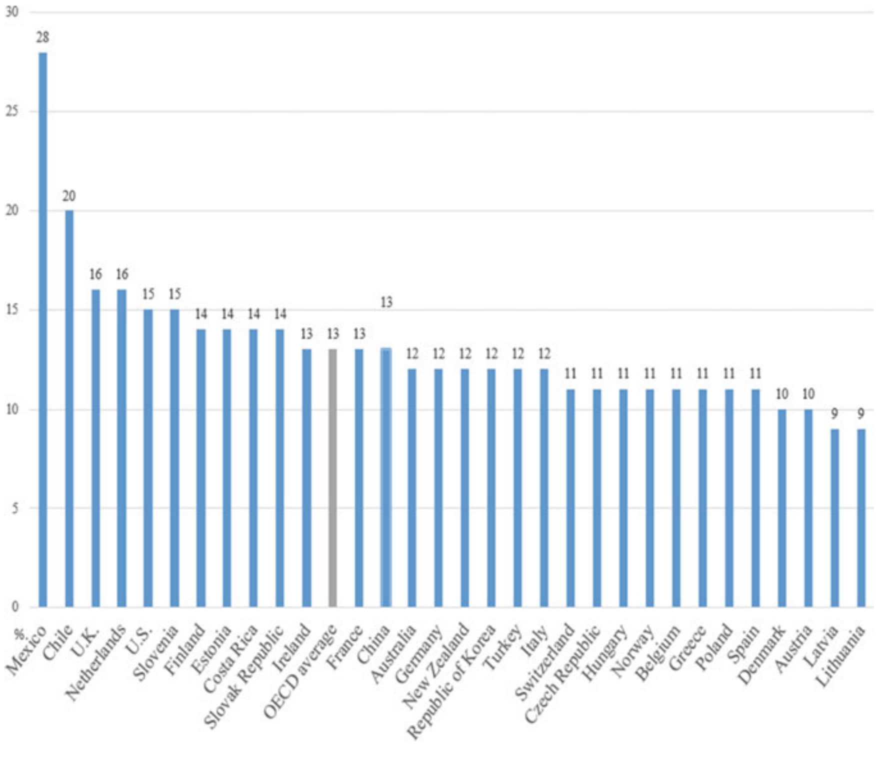

Fig. 1 Ratio of students to teaching staff in high school general programs (2019) (%). *Source* OECD (2021b), National Bureau of Statistics (2020a)

2.2 Percentage of Teachers Qualified According to National Standards

Percentage of teachers qualified according to national standards refers to the proportion of teachers possessing the minimum national academic qualifications required to teach a given subject at a certain level (UNESCO, 2022b).

It is necessary to measure and monitor the certification of teaching workforce. In 2008, Australia Education Alliance reported that 58% of public-school teachers were not eligible to teach their subjects, which negatively affected education quality (Zhang, 2009). The percentage of qualified teachers is predictive of the quality of education.

According to UNESCO, in UNESCO Institute for Statistics (UIS) regions, the average percentage of qualified teachers in high school education is 91.93% in 2020. The percentage varies sharply across the countries, from 19.91% in Ethiopia to 100% in 18 countries including Monaco, Jordan, and Thailand. China's percentage of qualified teachers at high school level is 90.04% with 1.89% percentage points lower than the average level in UIS regions (Fig. 2).

However, the national qualification requirements for teachers vary widely among different countries, and there are limitations on the international comparability at a fixed point in time. This chapter also examines the trend in China's percentage of qualified teachers. According to the UNESCO, between 2015 and 2020, the percentage of qualified teachers in China rose from 82.80% to 92.04%, while the average percentage of qualified teachers in UIS regions fell by 2.60% (Fig. 3). It can be seen from the comparison of the change trend that China's percentage of qualified teachers is likely to exceed the average level in UIS regions in the future.

2.3 Percentage of Teachers with a Bachelor's Degree or Higher

Studies indicate that educational quality is significantly associated with teachers' educational attainment (Rivkin et al., 2005). Despite the debates about the impact of teacher education level (Betts et al., 2003; Henry et al., 2014), many studies find that teacher education level is positively related to students' academic performance (Cooper & Cohn, 1997; Lee & Lee, 2020).

Since teachers' academic level could influence the quality of education, many countries have set minimum requirements on educational attainment for teachers. In China, high school teachers must have a degree of Bachelor's or above (MOE, 2021a). According to MOE, the percentage of teachers with a bachelor's degree or higher reached 98.62% in 2020. In accordance with OECD, in 2020, the average across the reporting OECD countries was approximately 97.89%, with the minimum of 83.00% in Iceland and maximum of 100% in Australia, Denmark, Finland, Germany, Hungary, the Republic of Korea (ROK), Netherlands, Poland, Portugal,

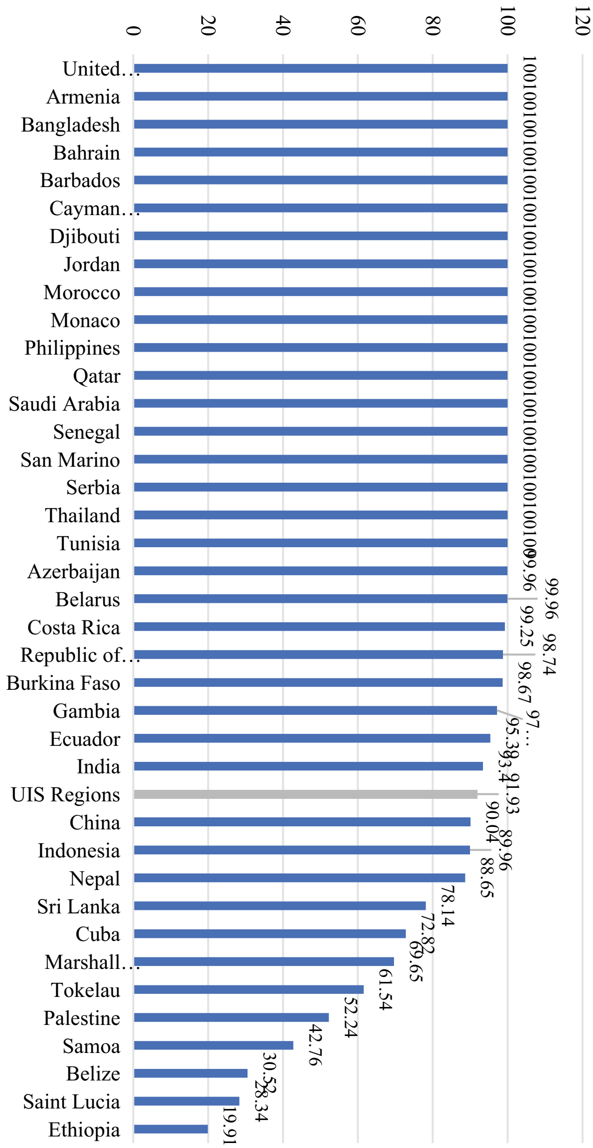

Fig. 2 Percentage of qualified teachers in high school education (2020) (%). *Source* UIS (2022a)

Spain, Turkey, and Scotland (the United Kingdom [U.K.]) (Fig. 4). It is important to note that the original data offered by OECD include the distribution of high school teachers by education levels according to the International Standard Classification of Education (ISCED). In the framework of ISCED, the 6th and above level correspond to a bachelor's degree or higher (Federal Ministry of Education and Research, n.d.). The data of this indicator were self-calculated based on the original data from OECD and the classification framework of ISCED.

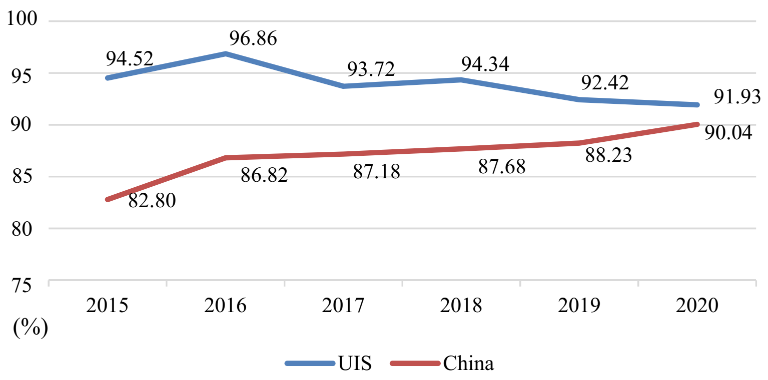

Fig. 3 Percentage of qualified teachers in high school education: 2015 to 2020 (%). *Source* UIS (2022a)

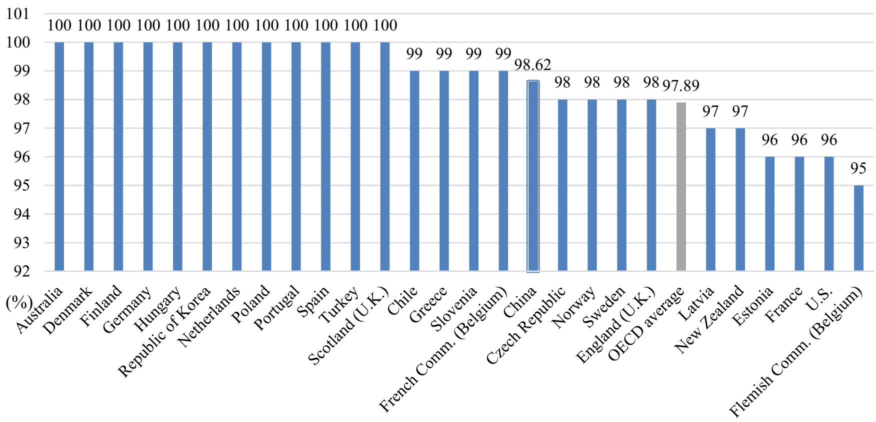

Fig. 4 Proportion of high school teachers with a Bachelor' s degree or higher (percent) (2020) (%). *Source* MOE (2020a), OECD (2021c). *Notes* The OECD average is calculated by using the data of OECD countries presented above

From the data above, China's percentage of high school teachers with a bachelor's degree or above is higher than the average of OCED countries. Furthermore, from 2009 to 2020, the percentage of teachers with a bachelor's degree or higher in China continued to rise, from 93.60% in 2009 to 98.62% in 2020 (Fig. 5). The statistics demonstrate both a slight international advantage and a steady increase in the academic level of China's high school teachers, indicating a great increase in the investment in teachers' human capital.

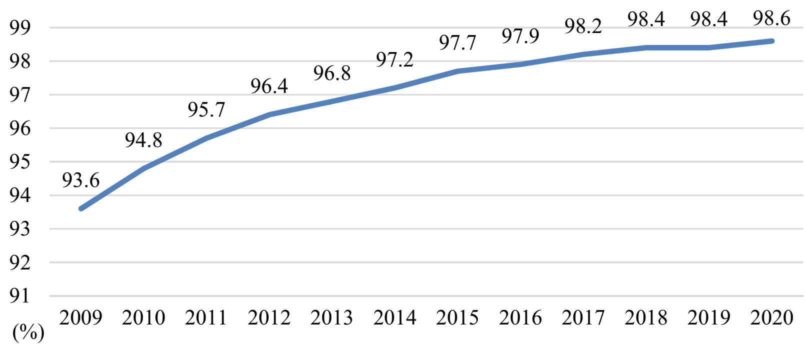

Fig. 5 Percentage of Chinese high school teachers with a bachelor's degree or above (%). *Source* Chen and Zhi (2019), MOE (2019a, 2020a)

2.4 Teacher Attrition Rate

The teacher attrition rate is the percentage of teachers who leave the profession. This indicator is calculated by dividing the number of leavers in a given year by that year's total teaching workforce, including new entrants (UNESCO, 2022c). A large value indicates that the teacher supply is unstable and insufficient, which could negatively affect students' learning and hinder the development of education.

According to UNESCO (Fig. 6), in upper-middle-income countries, the average attrition rate of high school teachers was about 4.60% in 2020. China's high school teacher attrition rate was 4.30%, lower than the average level of upper-middle-income countries, demonstrating a relatively more stable teacher population.

2.5 Total Expenditure Per Full-Time Equivalent Student, PPPs for GDP

Total expenditure per full-time equivalent student is an indicator that shows the amount of financial resources devoted to a single student on average, reflecting the degree of financial investment and support for education. It is calculated by dividing the total expenditure on educational institutions at a given level of education by the corresponding full-time equivalent enrollment (OECD, 2021d). To ensure the comparability across countries, expenditures in different national currencies are converted into equivalent U.S. dollars (US$) using Purchasing Power Parties for GDP (PPPs for GDP).

In 2018, OECD countries spent on average around US$10,581 per student in general programs at high school level. There were large variations among the reporting countries, ranging from less than US$6,000 per student in Chile, Greece, Mexico, and Turkey to more than US$14,000 per student in Luxembourg, Norway,

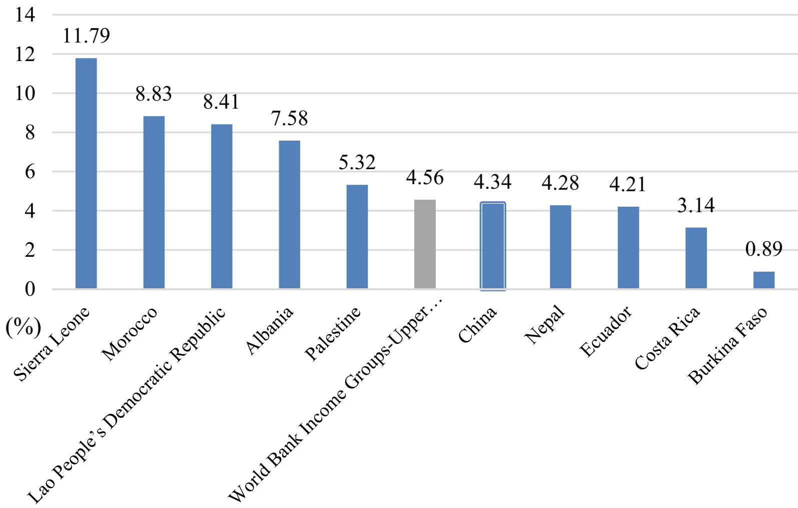

Fig. 6 Teacher attrition rate from high school education (2020) (%). *Source* UIS (2022b)

Belgium, Austria, Australia, France, and U.K. According to MOE, the 2018 total education expenditures per student in general high school education was RMB20,441 (around US$4,833). The PPPs for GDP of China was 4.228704, according to OECD. Figure 7 shows that China's level of expenditure per high school student was much lower than that of the majority OECD countries.

However, a lower level of average education expenditure does not necessarily represent a lower degree of financial investment in education. The level of spending per student can be affected by many factors, such as the number of students enrolled, the length of schooling, and teachers' salaries (OECD, 2021a), which vary significantly from country to country.

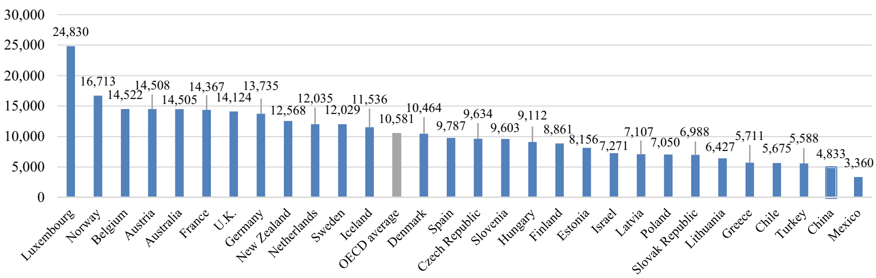

Fig. 7 Total expenditure per full-time equivalent student in general programs at high school level, PPPs for GDP (2018). *Source* OECD (2021d, 2022b), MOE (2019b)

2.6 *Total Expenditure on Educational Institutions as a Percentage of GDP*

National investment in education can also be evaluated by total expenditure on educational institutions as a percentage of GDP. It shows the share of a country's wealth produced in a period that has been spent on educational institutions. Not only can this measure indicate the priority placed on education, but it also demonstrates the degree of adaptability between the development of education and the economy. This indicator is also helpful to avoid some comparability issues, giving a more accurate picture of national investment in education.

In 2018, OECD countries spent an average of 0.6% of their GDP in general high school programs. The percentage ranged from lows of 0.2% in the Czech Republic and the Slovak Republic to highs of 1% in Chile and New Zealand and 1.4% in Israel. In 2018, China spent RMB472,100 million on general high school education (MOE, 2019b), while China's GDP reached RMB900,309 billion (National Bureau of Statistics, 2019). It is estimated that the total 2018 expenditure on general high school in China accounted for 0.52% of GDP. The data are presented in Fig. 8.

Although China's total expenditure on general high school education relative to GDP is lower than the average level of OECD countries, the gap is not large. Moreover, the total expenditure on general high school education as a percentage of GDP in China has risen from 0.52% in 2018 to 0.55% in 2020 (Fig. 9).

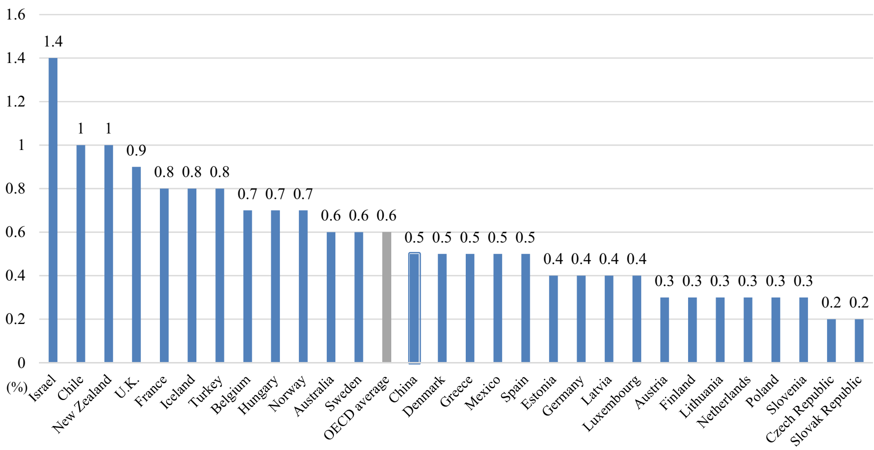

Fig. 8 Total expenditure on high school education as a percentage of GDP (2018) (%). *Source* OECD (2021e), MOE (2019b), National Bureau of Statistics (2019)

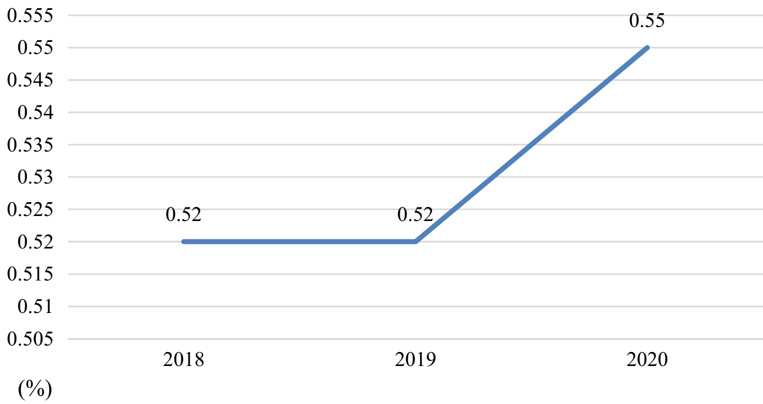

Fig. 9 China's total expenditure on high school education as a percentage of GDP (%). *Source* MOE (2019b, 2020b, 2021b), National Bureau of Statistics (2019, 2020b, 2021)

2.7 Proportion of Schools with Access to Internet

Effective instruction and learning environments require adequate school resources, including both human and physical resources. One of the necessary physical resources is internet access. Schools with internet access can use digital resources in education, which make teaching more effective. The proportion of schools with access to Internet could indicate the level of information facility investment.

According to UNESCO, the 2020 average proportion of high schools with internet access in UIS regions was approximately 65.5%. There is a significant variation across countries, with values ranging from lows of 1.09% in Burkina Faso and 6.72% in Sierra Leone to highs of 100% in nearly 30 countries such as Seychelles, Thailand, and Vietnam (Table 3). The proportion for China was 97.06%, above the average level.

Based on the overall indicators, several conclusions can be drawn. First, in terms of human resources investment in high school education (teacher investment in particular), China ranks high in international comparisons. The teacher workforce of high school education in China is above average in terms of adequacy, qualification level, and stability. Second, China's financial investment in high school education does not seem to keep pace with other countries. However, China is increasing its financial investment in high school education, and China is narrowing the gap gradually. Last but not least, with the advancement of the economy, science, and technology, investment in information technology (IT) is becoming increasingly important for the advancement of education. China's investment in IT equipment (e.g., cyber infrastructure) has performed well in international comparisons, providing a favorable condition for the modernization of China's high school education.

Table 3 Proportion of high school schools with access to Internet (2020)

Country	Proportion (%)	Country	Proportion (%)
Seychelles	100	China	97.06
Thailand	100	Malaysia	96.40
Vietnam	100	Tunisia	96.35
Cayman Islands	100	Lebanon	95.94
Cuba	100	Morocco	89.19
Dominica	100	Tonga	88.46
Grenada	100	British Virgin Islands	87.50
Saint Lucia	100	Kyrgyzstan	85.63
Albania	100	Turks and Caicos Islands	83.33
Andorra	100	Costa Rica	82.80
Gibraltar	100	Palestine	80.54
Monaco	100	Ecuador	78.41
San Marino	100	Colombia	77.60
Spain	100	Peru	75.27
Ukraine	100	Kiribati	75.00
Cook Islands	100	Algeria	73.37
Niue	100	Azerbaijan	72.81
Palau	100	Marshall Islands	72.22
Samoa	100	Zimbabwe	70.71
Tuvalu	100	UIS Regions	65.50
Armenia	100	Nepal	63.47
Bahrain	100	Senegal	60.77
Georgia	100	India	58.52
Jordan	100	Ivory Coast	54.35
Kuwait	100	Panama	53.11
Oman	100	Bangladesh	41.51
Qatar	100	Turkmenistan	31.10
Saudi Arabia	100	Cameroon	25.31
United Arab Emirates	100	Ethiopia	20.58
Belarus	99.52	Togo	14.06
Republic of Moldova	97.96	Sierra Leone	6.72
Bhutan	97.56	Burkina Faso	1.09

Source UIS (2022c)

3 Excellence Indicators

In recent years, educational scholars in China have actively promoted the development and evaluation of high-quality high schools. These scholars have explored a variety of indicators for evaluating and identifying excellent schools. However, merely focusing on China's excellent high schools is not enough; it is critical to examine top-performing high schools in an international context, which provides the foundation to understand and compare the strengths and weaknesses of excellent high schools across the globe. Given the challenges of data collection and ensuring international comparability, analysis in this chapter is limited to specific districts in China and the U.S.: Shanghai and California. These two regions have been selected due to their economic strengths and robust populations.

However, it needs to be noted that much of the school-level data are not publicly available for California's and Shanghai's high schools. As such, this chapter uses Shanghai and California as the contexts for the comparison mainly for illustrative purpose, and focuses on presenting definitions and possible sources for the indicators. In future studies, the research team will collect comprehensive individual-school data from Shanghai's and California's high schools, so as to conduct a full-scale comparison between Shanghai's high schools and California's high schools. Additionally, the research team would like to further understand if it is possible to examine high schools in other regions and districts from a global context using the indicators we established in this chapter.

3.1 Design

Three sets of indicators are chosen for examining high school excellence at the global level: input indicators, output indicators, and college readiness indicators (Fig. 10). Notably, the selection of indicators is constrained by two factors: data comparability and data availability.

3.1.1 Data Comparability

There are distinct disparities between the Chinese and U.S. national education systems, which renders the current comparison somewhat challenging. As such, quantifiable indicators that generally have comparable definitions in the global context are selected. To further strengthen the comparability, when the definitions and calculations are different between these two countries, the analysis will apply one country's definition and formula as the reference and adjust the other's indicator outcomes using raw data wherever possible.

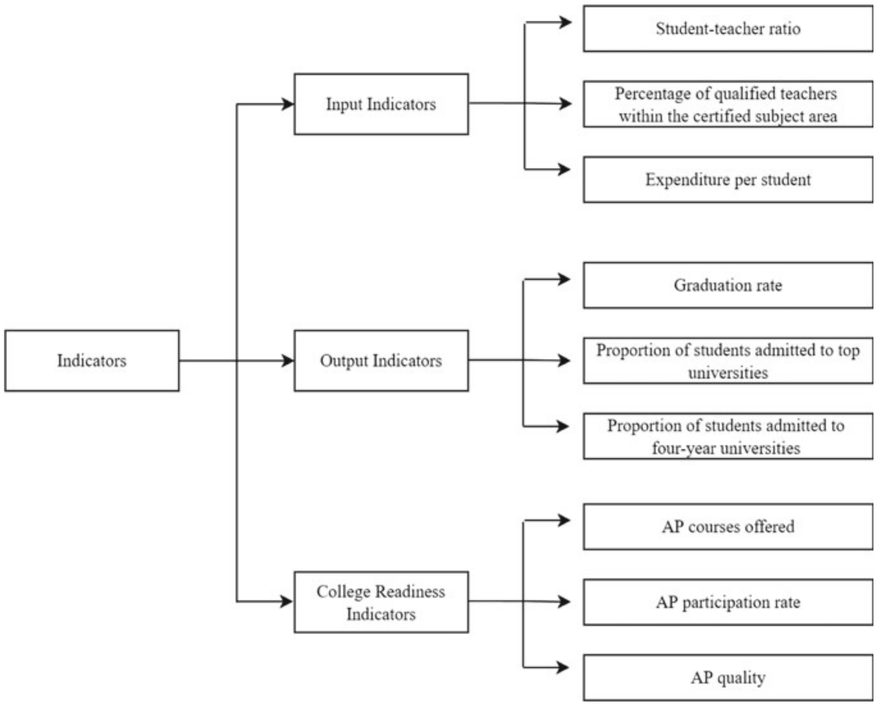

Fig. 10 Organizing framework of indicators

3.1.2 Data Availability

Preferably, data should be obtained from public sources to ensure transparency and validity. However, a great amount of data for China's and U.S. high schools are not publicly available. Fortunately, educational agencies and third-party organizations (e.g., U.S. News & World Report) provide school-level data on their official websites, along with definitions and calculation methods, offering a solid foundation for investigations. In other cases, information will be required from high schools and educational agencies directly for future investigations.

As a result, the indicators in this study draw upon operational definitions, data sets, and formulas from various sources, including National Center for Education Statistics (NCES), U.S. Department of Education, California Department of Education (CDE), Ed-Data (a partnership of the CDE), U.S. News & World Report, and Niche.

3.2 Definitions and Sources

The set of indicators for evaluating excellent high schools in Shanghai and California are listed in Fig. 10.

3.2.1 Input Indicators

There are three indicators under the input branch: student–teacher ratio, the percentage of qualified teachers within the certified subject area, and expenditure per student. Table 4 *contains the brief definitions of these indicators with the subsequent paragraphs providing additional details.*

Student–Teacher Ratio. The student–teacher ratio in a high school reflects the level of teaching resources available to students. The lower the ratio, the more personalized support a student may receive from the teachers. Prior studies find that student–teacher ratios are significantly related to student outcomes, including test scores and graduation rates (e.g., Brozak, 2017).

The student–teacher ratio is calculated by dividing the number of students enrolled in a given school year by the number of full-time equivalent teachers in the same year. Full-time equivalent teachers comprise any teaching personnel who are directly involved in the instruction of pupils, regardless of their employment status. The total number of full-time teachers should be added to the equivalency of part-time instructional staff converted to the statutory working hours of a full-time teacher to calculate the number of full-time equivalent teachers. However, the information regarding part-time instructional staff for Shanghai's high schools is not readily available, and we can only use total number of students and total number of teachers to calculate an approximate value. Thus, the student–teacher-ratio results between Shanghai's and California's schools are not strictly comparable, and are mainly presented for illustrative purpose.

For high schools in California, student–teacher ratios can be directly retrieved from the Common Core of Data (CCD) at NCES (RTI International, 2021). The ratios can also be verified from multiple sources, including U.S. News & World

Table 4 Operational definitions of the input indicators

Input indicators	Definitions
Student–teacher ratio	The ratio of total student enrollment to the full-time equivalent teachers
Percentage of qualified teachers within the certified subject area	The proportion of teachers that possess a full credential and teach the subjects within their certification area
Expenditure per student	The funding per pupil, allocated for the specific benefit of the school or the benefit of all schools in the Local Education Authority (LEA) equally

Report and Niche official websites. For high schools in Shanghai, data regarding the number of students and teachers can be obtained from school official websites and Baidu encyclopedia for most schools. As discussed previously, detailed part-time instructional staff information is not available for high schools in Shanghai, and may need to be collected from the schools directly in future investigations.

Percentage of Qualified Teachers within the Certified Subject Area. This indicator reflects the specialization level of teachers, which directly influences education quality. There is mounting evidence of the negative relationship between unqualified/mis-assigned teachers and student learning (Clotfelter et al., 2010; National Education Union, 2022; Van Overschelde, 2022).

The percentage of qualified teachers within the certified subject area is calculated by dividing the number of qualified teachers within the certified subject area by the total number of the teachers employed by the school (including the teachers without full credentials, such as internships, emergency, and waivers). The following formula shows the specific way this percentage is calculated:

$$\frac{(\text{Number of credentialed teachers} - \text{Number of credentialed teachers assigned out} - \text{of} - \text{field})}{(\text{Number of teachers with full credentials} + \text{Number of teachers without full credentials})} \tag{1}$$

For high schools in California, this percentage is obtained based on the information about teacher credentials and misassignment in the School Accountability Report Card (SARC) provided by CDE. For high schools in Shanghai, data are not readily available, and may need to be collected from the schools directly in future investigations.

Expenditure per Student. Expenditure per student indicates the estimated absolute amount of financial support for education on a per-student basis. A large body of evidence suggests that financial resources play a significant role in determining education quality (Baker, 2018). Prior studies have reported associations between increased educational spending and better student outcomes, including test scores and graduation rates (Jackson et al., 2015; Ted, 2014).

This indicator is calculated by dividing the total government funding allocated for a school in a given year by the school's annual Average Daily Attendance (ADA) figure. ADA is the pupil count used for funding allocation, obtained by dividing the total number of days of student attendance by the total number of days in a regular school year (Ed-Data, 2020). The reason for utilizing ADA rather than enrollment count is that ADA provides a more accurate student population statistic by accounting for transience, dropouts, and illness. In addition, given the different national currencies, this indicator will be converted into PPP$ to ensure international comparability.

Data regarding expenditures per student at high schools in the U.S. are obtained from SARC (California Department of Education, 2020). The matching data on PPP conversion factor can be retrieved from OECD Data. For high schools in Shanghai, data are not readily available, and may need to be collected from the schools directly in future investigations.

3.2.2 Output Indicators

There are three indicators under the input indicators branch: graduation rate, proportion of students admitted to top universities, and proportion of students admitted to four-year universities (see Table 5).

Graduation Rate. Graduation rate is one of the most important indicators for evaluating high schools. It is a well-accepted standard used by many education agencies, including U.S. News & World Report and Niche to measure high school success. Graduation rates also reflect school accountabilitythe level of education quality that a school can provide to its students to prepare them for further development. Furthermore, graduation rates may be related to other aspects of high school quality, including financial strengths, management capacities, curriculum resources, and teacher qualifications.

To ensure accuracy of the graduation rate indicator, the indicator is adjusted by Adjusted Cohort Graduation Rate (ACGR) (California Department Education, 2022). ACGR is calculated by dividing the number of students who graduate in the standard number of years or less by the number of students in the adjusted cohort for that graduating class (U.S. Department of Education, 2017). The adjusted cohort is based upon the number of the first-time 9th-graders in a particular academic year, and then subsequently adjusted by "adding any student transferring into the cohort and by subtracting any student who, during the years covered by the rate, transferred out, emigrated to another country, transferred to a prison or juvenile facility, or died" (U.S. Department of Education, 2017). For example, for a high school in Shanghai, its ACGR in school year 2021–2022 should be calculated as follows. Note that high schools in China typically cover Grades 10 to 12, while those in the U.S. typically cover Grades 9 to 12, which may render graduation rate slightly different due to grade coverage.

Table 5 Operational definitions of the output indicators

Output indicators	Definitions
Graduation rate	The percentage of first-time 9th grade students enrolled in the same school year that earn a regular high school diploma within the stipulated period
Proportion of students admitted to top universities	The percentage of students admitted to elite universities in China or the U.S
Proportion of students admitted to four-year universities	The percentage of students admitted to the government-approved four-year universities in China and the U.S

$$\frac{\text{Number of cohort numbers who earned a regular high school diploma by the end of the 2021}-\text{2022 school year}}{\text{Number of first}-\text{time Grade 9 students in fall 2019 (starting cohort)}+\text{students who transferred in}-\text{students who left during school years 2019}-\text{2022}} \tag{2}$$

For high schools in California, graduation rates are available from the SARC provided by the local educational agencies (LEAs). The data can also be retrieved from "state education agency public websites or received directly from state education agencies" (RTI International, 2021). For high schools in Shanghai, data are not readily available, and may need to be collected from the schools directly in future investigations.

Proportion of Students Admitted to Top Universities. This indicator reflects talent training quality. Top universities can provide outstanding learning opportunities and educational resources. Admission to top universities is highly competitive and demands outstanding abilities. The proportion of students admitted to top universities reflects how successful a high school is in student development.

For U.S. institutions, the top 4 universities are defined based upon Times Higher Education (THE) World University Rankings, and THE Ranking is generally considered one of the leading rankings for world universities (Times Higher Education, 2021). Based upon THE ranking, for U.S. institutions, the top 4 universities are: Harvard University, Stanford University, Massachusetts Institute of Technology, and California Institute of Technology. For China's institutions, the top 4 universities are: Tsinghua University, Peking University, Fudan University, and Shanghai Jiao Tong University. These eight universities have been recognized as the leading universities in these two countries.

For high schools in California, data are not readily available, and may need to be collected from the schools directly in the future. For high schools in China, data are obtained from official school websites, Xibao (a bulletin of glad news), university admission office, and other websites (e.g., WeChat official accounts). In particular, information obtained from official school websites, Xibao, and university admission office is considered to be of high accuracy, and we prioritize these sources for calculation. The information obtained from other websites may vary, and we only use these websites when information from official sources is not available. Additionally, we use multiple sources to crosscheck the accuracy of the data wherever possible.

Proportion of Students Admitted to Four-Year Universities. It refers to the percentage of students admitted to the government-approved four-year universities in both countries.

For high schools in Shanghai, data are obtained from official school websites and other websites (e.g., WeChat official accounts). For high schools in California, data are not readily available, and may need to be collected from the schools directly in the future.

3.2.3 College Readiness Indicators

There are three indicators under the input indicators branch: AP courses offered, AP participation rate, AP quality (see Table 6).

One of the goals of high school education is to prepare students for post-secondary education. Therefore, this chapter took college readiness into consideration while evaluating excellent high schools. College readiness refers to a set of skills, knowledge and behaviors a high school student should have before enrollment in their first-year college. These may include subject-specific knowledge, creativity, the capacity for independent learning, and other aspects. Advanced Placement (AP) courses are designed to improve college readiness.

Not until recent years, China's high school education has started to attach great importance to college readiness. A group of educators are actively exploring how to set up China's AP courses (also known as CAP). For instance, Peking University's Advanced Courses (AC), Tsinghua University's MOOCAP, and Chinese Advanced Placement created by the Chinese Society of Education (CSE) are three typical examples (Liu, 2016; Shao, 2021; Si, 2016; Yang, 2016). These programs have established a complete course system, including teacher training, AP designation, AP enrollment, course assessments, and credit certification methods. There are many similarities between the programs and the American AP courses, allowing for cross-national comparisons. However, it is worth noting that the AP programs in China are still at the preliminary stage of development and are only available at a few selected Chinese post-secondary institutions. As such, the values of the three college readiness indicators in China's high schools may not be parallel to those in the U.S.

AP Courses Offered. AP courses offered indicates the abundance of AP course resources. It is calculated by counting the authorized courses with at least one student enrolled. Specifically, the courses should meet the following two criteria. First, the courses must be authorized by the organizations that provide the AP courses. Second, at least one student should register for the course.

For high schools in California, the number of AP courses offered are available from SARC. For high schools in Shanghai, data are not readily available and may need to be collected from the schools directly in the future.

Table 6 Operational definitions of the college readiness indicators

College readiness indicators	Definitions
AP courses offered	The number of authorized AP courses with at least one student enrolled
AP participation rate	The percentage of students enrolled in all AP courses at the school for a given school year
AP quality	The percentage of AP tests on which a student obtained a passing score or higher

AP Participation Rate. AP Participation Rate can be used to measure access to college-level material (RTI International, 2021). It is computed by using the total number of unduplicated students enrolled in AP classes divided by the total number of unduplicated students enrolled in the same year.

For high schools in California, the number of AP courses offered are available from SARC. For high schools in Shanghai, data are not readily available and may need to be collected from the schools directly in the future.

AP Quality. AP quality refers to the AP test outcomes. This indicator measures students' readiness for college-level work (*ibid*). It is calculated by dividing the number of AP exams on which a student obtained a passing score or higher (e.g., a score of 3 or higher on AP exams in the U.S.) by the total number of AP exams taken in a school year. If a student took multiple AP exams, all of them will be counted.

For high schools in California, the values of this indicator can be obtained based on the AP test results offered by ED-data. For high schools in Shanghai, data are not readily available and may need to be collected from the schools directly in the future.

3.2.4 Sample

In order to demonstrate the operationality of the definitions and formulas, we selected 12 leading high schools from California. Specifically, we used the 2022 Best U.S. High Schools Rankings from U.S. News & World Report (2022) for the selection of leading U.S. high schools because this ranking also strives to examine high schools using publicly available data. These schools are Gretchen Whitney High School, California Academy of Mathematics and Science, Preuss School UCSD, Lowell High School, University High School (Fresno), Mission San Jose High School, Lynbrook High School, Eunice Sato Academy of Math & Science, Monta Vista High, Western Center Academy, Canyon Crest Academy, and Dougherty Valley High School.

For high schools in Shanghai, although there is no official ranking available, there are twelve schools that are generally considered leading institutions in Shanghai (Gong, 2020). These schools are Shanghai High School, No. 2 High School of East China Normal University, High School Affiliated to Fudan University, High School Affiliated to Shanghai Jiao Tong University, Shanghai Qibao High School, Shanghai Nanyang Model High School, Shanghai Kong Jiang Senior High School, Shanghai Jianping High School, Shanghai Yan'an School, Shanghai Fuxing Senior High School, Shanghai Datong High School, and Shanghai Gezhi High School.

3.3 Findings

The results of the averages of the indicators for excellent U.S. high schools are presented in Table 7.

Table 7 Indicator averages for excellent California's and Shanghai's high schools

Region	STR	PQT	EPS	GR	PSTU	PS4U	APC	APPR	APQ
California	25/1	94%	10,275	98%	N/A	N/A	53	58%	77%
Shanghai	10/1	N/A	N/A	N/A	26%	99%	N/A	N/A	N/A

Notes STR refers to student–teacher ratio; PQT refers to percentage of qualified teachers within the certified subject area; EPS refers to expenditure per student; GR refers to graduation rate; PSTU refers to proportion of students admitted to top universities (e.g., High School Affiliated to Shanghai Jiao Tong University, 2022; Shanghai High School, 2022a); PS4U refers to proportion of students admitted to four-year universities (e.g., Shanghai High School, 2022b); APC refers to AP courses offered; APPR refers to AP participation rate; APQ refers to AP quality. Not all data from all high schools are available for each indicator; only the averages are reported

3.4 Discussion

There are notable differences between California's and Shanghai's high schools. For instance, there was a substantial difference for student–teacher ratio: the STR is 25/1 for top California's public schools, and the STR is 10/1 for top Shanghai's high schools. However, we shall not overinterpret the differences, as: (1) The total number of full-time teachers was added to the equivalency of part-time instructional staff converted to the statutory working hours of a full-time teacher to calculate the number of full-time equivalent teachers for California's high schools; while we only used the total number of teachers and students to calculate STR for Shanghai's high schools, as the detailed part-time instructional staff information was not available. (2) There are significant enrollment differences between top public and private high schools, and we only focus on public high schools for both countries for this round of analysis.

Again, the AP programs in China are still at the preliminary stage of development and are only available at a few selected Chinese post-secondary institutions. The values of the three college readiness indicators in Chinese high schools collected in the future may not be parallel to those in the U.S. Additionally, dual enrollment programs are becoming an increasingly popular option in the U.S. which is a direct challenger to AP course offerings and enrollments.

Additionally, not all data are publicly available for U.S. high schools, such as proportion of students admitted to top universities and proportion of students admitted to four-year universities. Preliminary results show that 26% of students from the 12 leading high schools enrolled in top-4 universities in China, and 99% students attended 4-year universities. Future investigations should collect data from individual schools or districts for U.S. high schools.

Finally, although the comparative analysis is limited given the lack of publicly available data for Shanghai's and California's high schools, individual-school data will be collected from Shanghai's and California's high schools, so as to conduct a full-scale comparison between Shanghai's high schools and California's high schools. Specifically, detailed data may be collected from school officials and government agencies. Additionally, the research team would like to further understand if it is possible to examine high schools in other regions and districts from a global context using the selected indicators in this chapter.

4 Best Practices

4.1 Cultivation of Innovative Talents in Chinese High Schools

The competition of comprehensive national strength lies in the competition among innovative talents. Countries across the globe have realized the significance of innovative talents, and thus are actively developing their abilities to research and improve the practice of innovative student development.

China has attached great importance to the cultivation of innovative talent (*chuangxin rencai peiyang*). *Outline of the National Plan for Medium- and Long-Term Education Reform and Development (2010–2020)* issued in 2010 clearly puts forth the necessity to reform talent training mechanisms and modernize the talent training mode. It also emphasizes that the high school is a critical period for the formation of students' personality, which is of great significance to the cultivation of innovative talents (the State Council, 2010).

Many high schools in China have explored their own effective and distinctive training systems for innovative talent. In this section, two schools as talent-innovation representatives are presented. One is Shanghai High School, which has been taking the lead in carrying out the experimental project of cultivating high school students' innovative literacy in China (Feng & Liu, 2019), and the other is No. 2 High School of East China Normal University (NHSECNU), one of the first "top-10 schools in science and technology innovation education" (NHSECNU, 2022a). In the following paragraphs, details are told regarding their talent-innovation cultivation approaches.

4.1.1 Moral Education (*Daode Jiaoyu*) Comes First

Moral education refers to activities that purposefully exert moral influence on students. The contents include improving moral consciousness and understanding, cultivating moral emotion, exercising moral will, establishing moral faith, and forming moral habits.

The cultivation of innovative talent needs to put moral education first. The NHSECNU features "Moral Education Leading Innovation" in its cultivation of innovative talent (Sheng, 2010). Moral education is highly valued at the school. It initiates a mode for talent cultivation named "100% x N", which calls for all students (100% students) to complete N tasks (NHSECNU, 2022b). One of the tasks, 100-h volunteer work, is designed to develop students' moral character (NHSECNU, 2021). Similarly, Shanghai High School also emphasizes the significance of moral education. When the school created its original course groups for innovative talent cultivation, one of the first approaches they came up with was to create a moral education curricula group (Feng, 2016). Survey results from Shanghai High School showed that 96.3% students agreed that moral character would greatly influence the future student development (Feng, 2015).

4.1.2 Providing Sufficient Space for Students to Explore Their Potential

Individual development is necessary for students with varying potential. This requires schools to provide students with sufficient space to explore their potential. The NHSECNU initiated a program named "College of Excellence" in 2013. This program offered a wide range of courses and provided personalized cultivation in accordance with students' innovation potential and subject specialties, aiming at promoting each student to fully explore their own potential (NHSECNU, 2022c).

Shanghai High School has creatively built a highly selective curriculum system with its own characteristics based on the idea of "subject cluster" from International Baccalaureate (IB) courses. The curriculum system is divided into three categories: a course group regarding learning (nearly 500 courses), a course group regarding moral education (nearly 40 subjects and 150 modules), and a course group regarding potential development (involving finance, law, energy-saving cars, medicine, software engineering, brain science and artificial intelligence [AI], geographic information systems and other discipline areas) (Feng, 2016). Students can freely choose the courses and develop their advantageous potential according to their learning bases and research interests.

4.1.3 Collaborating with Top Universities and Scientific Research Institutions

The cultivation of innovative talent needs support of good teachers, while teachers in ordinary high schools are inadequate when cultivating innovative talents in terms of knowledge, teaching methods, and time. Many high schools collaborate with universities or scientific research institutions to cultivate innovative talents.

Since 2014, Fudan University (FDU) and Shanghai High School have jointly promoted the "FDU-Shanghai High School mentoring plan", including "office hours" (academic seminars with the professors from FDU), cross-disciplinary lectures, micro-courses with difficulty equivalent to a college course, summer courses offered by FDU, online guidance, and MOOC learning (Feng, 2021). Additionally, Shanghai High School has also worked with prestigious universities and research institutions such as Shanghai Jiao Tong University, Tongji University, and the Institute of Neuroscience of the Chinese Academy of Sciences (CAS) to cultivate innovative talent (Feng & Liu, 2019). NHSECNU has incorporated the "Talent Program" (a training program for youth science and technology innovation talent) organized by the Chinese Association for Science and Technology and MOE into its cultivation system (NHSECNU, 2022d). Through the "Talent Program", students can conduct research under the guidance of top scientists in China and develop their pioneering spirit and innovative ability.

Thanks to the assistance of universities and research institutions, students can make great achievements and access resources that they would not have had otherwise. For instance, through the training of the "Talent Program", four students from the NHSECNU are qualified to have an asteroid named after them because of their exceptional performance in Intel International Science & Engineering Fair (ISEF) (NHSECNU, 2022b), demonstrating to the world the innovative potential of Chinese youth.

*4.2 The Exploration of Liberal Education (***Boya Jiaoyu***) in Chinese High Schools*

Liberal education is a long-established educational philosophy that emphasizes the cultivation of a "harmoniously developed" person with a wide range of knowledge and a noble moral character through the accumulation of extensive knowledge and the cultivation of refined humanistic spirits (Su, 2013). Studies have shown that liberal education has a positive effect on both individual development and socio-economic development (Axelord & Anisef, 2001; Wang, 2015). Thus, many scholars are exploring how to put liberal education into practice. However, practicing liberal education in high school settings, especially in China, is quite challenging (Wang, 2015). This is mainly because China's high school students are under a lot of pressure to prepare for college entrance exams (*gaokao*) and have little time to pursue liberal education. However, the High School Affiliated to Fudan University has explored an effective way to practice liberal education from which much can be learned.

4.2.1 Shaping a School-Based Philosophy of Liberal Education

It is critical to think carefully about two questions for a school to practice liberal education: What is liberal education? What kind of people does the school want to cultivate through liberal education? Jian Wu, Principal of High School Affiliated to Fudan University, gives a clear answer to these questions (Wang, 2021). Liberal education pursues students' holistic development (*quanmian fazhan*), diversified growth, and sustainable progress. Students should be trained to "*Bo er Tong, Ya er Zheng* (have a complete knowledge system and good conduct)". Wu highlights the importance of developing moral character in the age of intelligence and highly recommends that teachers develop students' spiritual beliefs in accordance with the Chinese culture. Chinese teachers in this school have developed a course group named "Chinese People" (*zhong guo ren*), including "the Chinese Characters", "Chinese Ancient Poetry Appreciation", and "Chinese Root Culture" (Zhou, 2019). It is designed to help students internalize good virtues of Chinese culture while learning literary knowledge.

4.2.2 Constructing a Curriculum System to Meet Students' Various Needs

The school has established a curriculum system consisting of eight sections, which are Humanities and Classics, Language and Culture, Society and Development, Teaching and Logic, Science and Experiment, Technology and Design, Sports and Health, Art and Appreciation. Under each section, a certain number of courses are offered for students to choose. For instance, Sports and Health has up to 74 courses for students to choose (Wang, 2021). The school has also set up a "four-step" progressive curriculum system. The "four steps" are: level A—basic courses to ensure basic learning abilities, level B—expanding courses to meet students' individual needs, level C—research courses to cultivate scientific research abilities, and level D—selective courses to develop potentials. Students have autonomy in deciding whether to take courses above level A. In this curriculum system, students can learn a wide range of knowledge at their own pace.

This school encourages students not only to learn a wide array of subjects, but also to conduct cross-disciplinary research. During the World Expo, the school gathered nearly 10 teachers from different disciplines, including Chinese, Geography, Physics, and Politics to co-edit a book titled the "World Expo Tour" (Fu & Li, 2011). Inspired by this book, many students found inter-disciplinary topics fascinating to study, and developed their abilities to apply cross-disciplinary knowledge.

4.2.3 Constructing a Multiple Evaluation System to Encourage Diversified Development

Principal Wu believes that while assessment scores are important, they are not the purpose of learning (Xu, 2021). Students need to be evaluated thoroughly. Therefore, the High School Affiliated to Fudan University established a multiple evaluation system for students (Yu, 2016).

First, in order to lessen the tendency to evaluate students by scores, each student's test scores are converted into corresponding grades. Furthermore, there are variations in the methods used to evaluate students for courses at various levels. Basic course evaluations include daily performance, midterm grades, and final grades. Research courses are evaluated by P (pass/qualified) and NP (not pass/unqualified). In selective courses, students will not receive grades; instead, their performance in these courses will be presented in terms of overall quality (*zonghe suzhi*) reports.

Overall quality reports are used to assess students' holistic development. Apart from academic performance, these reports record the students' performance in various extracurricular activities such as volunteer service, awards and honors they have received, and semester comments from their teachers. The information presented in the reports will be used as an important basis for student awards. The school has set up different kinds of honorary awards, including "star of volunteer work", "star of arts and sports", "star of science and technology" (Wang, 2021). These different types of "stars" form a multi-symbiotic model group, which increases students' awareness of multi-dimensional development.

4.3 China's High School-Centered Education Groups for Educational Balance

In 2019, Chinese government issued several documents to promote the balanced development of education (*jiaoyu junheng fazhan*), for example, *The Implementation Plan for Accelerating the Modernization of Education (2018–2022)* (the State Council, 2019a) and *China Education Modernization 2035* (the State Council, 2019b).

To realize the balanced distribution of educational resources, the government put forward an excellent school-led development strategy, which encourages high-performing high schools to open branch schools and establish education groups. A number of education groups have been established, such as High School Affiliated to Shanghai Jiao Tong University Education Group, Hangzhou Qiushi Education Group, and Beijing Fengtai No. 1 Primary School Group, etc.

As early as 1996, Shanghai Jianping High School started to open branch schools and formed Jianping Education Group, the first education group in Shanghai (Huang & Luo, 2016). It is one of the representatives of group-schooling in China and the experience of this education group can be learnt from.

4.3.1 School Culture Comes First

Educational philosophy is vital to running a school. Shanghai Jianping High School attaches great importance to the creation, transmission, and growth of school culture in the process of opening branch schools.

In 1994, the former Meiyuan Middle School was renamed Shanghai West Jianping Middle School and joined Jianping Education Group (Chen & Xue, 2016). Shanghai Jianping High School sent a cadre of teachers and experienced education administrators to the West Jianping Middle School. These teachers were instrumental in the development of the middle school. Furthermore, the educational philosophy of Shanghai Jianping High School, "qualification + specialization; norm + choice", has also greatly influenced the development of Shanghai West Jianping Middle School. It established a credit system based on this educational philosophy (Jiangsu Education Newspaper, 2021a). The credit is calculated by adding "basic credit" and "specialty credit". To allow students to explore more about their specialties, Shanghai West

Jianping Middle School has developed more than 90 selective courses for students to choose (Jiangsu Education Newspaper, 2021b).

It is worth mentioning that Shanghai West Jianping Middle School has also creatively developed its own school culture based on the educational philosophy of Shanghai Jianping High School. This middle school nurtures its idea of "realizing the vigorous growth of each student" based on the two words "specialty" and "choice" (*ibid*). This new idea not only adds humanistic charm to Shanghai West Jianping Middle School, but also enriches the educational philosophy of Jianping Education Group.

4.3.2 Realizing Resource Balance Through Resource Sharing

Educational resources, especially teachers, are extremely important to school development. Pudong Middle School, before being a member of the Jianping Education Group, had inadequate instructional resources. After Pudong Middle School joined the Jianping Education Group, Shanghai Jianping High School assigned a math teacher and an English teacher to Pudong Middle School (Huang & Luo, 2016). The two teachers were experienced in teaching graduates at Shanghai Jianping High School. They introduced many efficient techniques for class management and lesson preparation to the middle school. After a semester, students' scores significantly improved. Additionally, the teaching abilities of the teachers in Pudong Middle School also progressed.

It is clear that Jianping Education Group may raise the standards of both students and teachers in underprivileged schools through internal resource reallocations. This further supports the balanced development of fundamental education.

4.3.3 Ripple Effect Within the Education Group

With the development of Jianping Education Group, many schools in this group have gradually grown/evolved from "recipients" to "helpers", and started to help promote the development of other schools within the education group, which is called a ripple effect.

Take Jianping South Middle School as an example. There was a severe staff shortage when Jianping South Middle School joined the Jianping Education Group. It only had the principal in its management team, which seriously hampered its development. Facing this huge problem, other schools in the education group all came to help (*ibid*). Three excellent teachers from Shanghai West Jianping Middle School—a special-grade physics teacher, a senior math teacher, and an experienced teacher from the Subject Center—went to Jianping South Middle School to train the teachers. Meanwhile, a gold-medal coach specializing in designing fire-fighting robots was sent to train the students in the robot team of Jianping South Middle School. Jianping Yuanxiang School also sent four experienced teachers to Jianping South Middle School. With the joint support of several schools Jianping South Middle

School was transformed from an ordinary school to a school with high teaching quality and great social recognition in a short period of time.

5 Inspiring Stories

5.1 Zhang Guimei: Female Education in Rural China

Huaping High School for Girls in Southwestern China's Yunnan province is a small but well-known local school in a rural area. It is the first free all-girls public high school in China. Since its founding in 2008, it has helped nearly 2,000 girls enter the universities and have a chance to change their lives (China Daily, 2021). This could not have happened without the principal, Zhang Guimei, who has spent most of her life fighting against the educational inequalities girls face in rural areas.

5.1.1 Determined to Build the First Free-of-Charge High School for Girls in China

Many years ago, as a teacher in Huaping County, Zhang noticed that girls were less likely to further their education after finishing middle school. One of the reasons is that families do not expect girls to have high-level education. As a result, many families are not willing to pay the tuition fees for female students for the high school. While working as a part-time president of a local welfare center for children, Zhang learned from many cases that K-12 is a key period of growth, regardless of gender. Furthermore, female students will grow to be children's mothers, who play significant roles in students' lives, and thus should receive good education to be able to educate their children (CGTN, 2021). Zhang decided to find a tuition-free school just for girls from the mountainous areas for poor families.

5.1.2 Dauntless Efforts and Selfless Dedication

There was nothing easy about setting up a school like this. One of the toughest challenges was fund-raising. To raise enough money for the school, Zhang spent all her holidays on the streets, handing out leaflets and asking for donations. Many people thought her a fraud and refused to contribute. Some people even set dogs on her. After five years, she had collected only RMB10,000 (around US$1,500), far from enough to open a school (China Central Television, 2020).

Zhang's situation changed in 2007, when she was elected to attend the 17th Communist Party of China National Congress. At the meeting, a journalist noticed her and reported on her story. Soon after, her dream was known by the public. In a short time, she received a large number of donations sufficient for founding the all-girl high school.

In September 2008, the Huaping High School for Girls began its operation (MOE, 2020c); however, new challenges emerged. Although people knew the school was free, they hesitated to send their girls to the school. Some of the families were less confident about the new school, but more were worried that even if the girls could pass the college entrance exam, their families would still not be able or willing to pay for college. To persuade these parents, Zhang visited families, door to door, and told them that "knowledge could change lives; sending the girls to schools or college may change both the girls' and the next generations' lives" (CGTN, 2021).

Gradually, more and more students started to come to the school. However, Zhang found that most girls had poor learning foundation because they did not receive adequate education before, which was worrisome. To encourage the students to study hard, she walked around the school with a loudspeaker every day, reminding students to make the best use of every moment. Sharing the same faith with Zhang, the entire teaching staff in the school also worked hard to support every single student.

Under the efforts of everyone involved, the Huaping High School for Girls became better and better; however, her health condition worsened. Years of overwork had caused great damage to her health. She was diagnosed with more than 20 diseases, including osteoma, hemangioma, and emphysema (Teller Report, 2021). Instead of receiving medical treatment in the hospital, she continued working for the students and taking multiple medications to alleviate her pain. One day in 2018, she could not even bear the pain and fainted. After a series of surgeries, she was finally out of danger. When she woke up, she said, "Can I have an advance on my funeral expenses? I want to spend the money on school construction," which moved everyone present to tears (People's Daily, 2020). In spite of her terrible health condition, she went back to work the next day.

As Zhang said, she contributed almost everything she had. During the past years, she worked year-round, despite suffering from various diseases. Intending not to let any girl fall behind in schooling, she insisted on home visits for 11 years, and visited more than 1,300 families, traveling more than 100,000 km (MOE, 2021c). She has given most her money to the school, her students, and their families. She always thinks of others but never of herself.

5.1.3 Yeas of Dedication in Return for Good News

Since the founding of the school, nearly 2,000 students have graduated and received higher education at universities, including prestigious ones such as Wuhan University and Xiamen University (China Daily, 2020). As Zhang hoped, the girls went out of the mountains and thrived in various fields. It is worth mentioning that some of the girls returned to the mountainous areas and became teachers, continuing the fight against educational inequality.

Thanks to Zhang's endeavors to improve female education in the poor areas in China, more and more girls can change their lives and their children's destinies. She not only awakens the life goals of rural girls, but also encourages more educators to follow their educational dreams.

5.2 Yu Yi: Making Education a Life-Long Mission

On September 29, 2019, Yu Yi, the honorary president of Shanghai Yangpu Senior High School, received the award of People's Educator, a national honorary title, in recognition of her outstanding contributions to primary and secondary education in China (MOE, 2021d).

Yu has spent more than six decades teaching Chinese language and literature. During her teaching career, she has taught nearly 2,000 high-quality exemplary classes (China Daily, 2019). Based on her teaching experience, she formed an original teaching philosophy. Many of her viewpoints were accepted by MOE, producing a profound effect on national education reform (Yangpu News, 2019). Moreover, she also made outstanding advances in school governance and teacher education.

5.2.1 A Chinese Language Teacher: Constantly Striving for Excellence

At first, Yu was not a Chinese language teacher, but a history teacher. She switched to Chinese language teaching because her school had a lack of Chinese language teachers. It was a significant challenge for her, since she knew little about the Chinese language and literature. To ensure teaching quality, she made efforts to learn professional knowledge. Every day after finishing work, she would stay up late to study. Within two years, she equipped herself with the kind of knowledge that a Chinese language teacher should have. Yu also worked hard on lesson preparation. Each time she prepared a lesson, she pushed herself to study on her own rather than following teachers' guidebooks. To make her class as attractive as possible, she wrote down what to say in class, modified the words iteratively, and practiced a lot. She treated every class as a work of art, endeavoring to perform better. In 1978, Yu became one of the first group of supreme teachers in China (MOE, 2019c). However, she was not satisfied. She always reflected on her craft, trying to find deficiencies and learn from others' strengths to overcome her shortcomings. Through constant reflection, she kept making progress in teaching. As a result, 50 of her exemplar courses are recognized as milestones in Chinese Education Reform (China Daily, 2019).

5.2.2 An Education Reformer: Sharply Criticizing Malpractices

In the 1980s, many people tended to take Chinese education as a language tool. However, Yu put forward a different point of view that Chinese is a subject that combines instrumentality with humanity: the language of each nation is not only a symbolic system for communication but also a system containing cultural and emotional values (Yu, 1995). She emphasized that Chinese teaching should not only focus on language knowledge but also on cultivating students' humanistic spirit. Her viewpoint aroused heated discussion and gradually gained acceptance from more and more people. In 2001, as part of reforms in the Chinese curriculum, MOE accepted Yu's suggestion and added "humanity" to the Chinese Curriculum Standard (MOE, 2021d). Based on the "humanity theory", Yu further expressed her opposition to the utilitarianism in education and emphasized well-rounded development for students. She pointed out that the priority of education is to help students realize their full potential and enrich their spiritual lives (Yu & Tang, 1999). It is important to note that the issues Yu criticized many years ago are still relevant today. Many of her ideas have a significant impact on the development of elementary education in China.

5.2.3 An Educational Administrator: Contributing to School Development

In the mid-1980s, Yu was appointed principal of Shanghai No. 2 Normal School, where the school climate was poor. The teachers were often late to work, and many students put focus on things other than their studies. Even worse, gambling and excessive drinking activities were frequently found in school. Yu was keenly aware of the needs to prioritize school spirit. She took several measures, including setting up an office-hour system and regulating school uniform. A few years later, the school had changed beyond recognition. It became well-known for its excellent school spirit and received a national commendation (People's Daily, 2021). She summed up the practical experiences and formed a theoretical system for managing schools, providing many valuable suggestions for school development.

5.2.4 An Educational Administrator: Contributing to Teacher Development

To accelerate young teachers' growth, Yu initiated a cultivation program, where a novice teacher received guidance from three aspects (People's Daily, 2021). Every novice teacher would have a mentor and join a teaching group, receiving individual instruction from the mentor and collective training from the teaching group. An additional accountability system was prepared to ensure the quality of teacher training. Many novice teachers have benefited from this kind of cultivation model. Additionally, Yu has cultivated three generations of top-class teachers (Xinhua, 2019). Furthermore, Yu found a lack of systematic research on teacher development in China and decided to fill the gap. Based upon her continual efforts, the first work on contemporary teacher education in China—*Xiandai Jiaoshixue Gailun (Introduction to Modern Pedagogy on Teacher)* was published in 2001 (China Education Daily, 2018).

5.2.5 A Life-Long Educator

Over the past decades, Yu has devoted herself to China's education with a strong sense of mission and made remarkable contributions. Now, she is more than 90 years old, but still pays close attention to the education reform in China. She says that the imperative of educational reform is to establish a pedagogy with Chinese characteristics (*ibid*). Despite her age, she is still looking forward to it and continues to work. Her motto is: to be a life-long educator (*ibid*). For her, education is a life-long mission.

5.3 Bian Yuexia: Educator Fighting Against COVID-19

"If not for COVID-19, I should have retired." Bian Yuexia, a high school teacher in Shandong Jinan Tibetan High School, said to a reporter (China Education Daily, 2020a).

Bian is a teacher in charge of the daily lives of the students at the only boarding school in Shandong Province that accepts Tibetan students. There are a total of 794 students in the school (*ibid*). Students typically do not return home for the entire school year, including the spring festival.

5.3.1 Volunteering to Stay at School to Watch Over Her Students

To take care of her students, Bian stays at school every spring festival, spending time with her lovely students. However, in 2020, she planned to go home to spend Chinese New Year with her parents, as she would reach retirement age before the Chinese New Year came that year.

Unfortunately, COVID-19 broke out in Shandong Province in early 2020. Although Bian really wanted to go home, as the teacher in charge of students' daily lives, she could not bring herself to leave her students in such a situation. She decided to put off her retirement and stay in school to ensure the well-being of her students. Bian returned her plane tickets and told her parents that she would not return to be with them until the pandemic was over. Despite feeling upset, Bian soon prepared herself for a fight against COVID-19 and for her students.

5.3.2 Ensuring Students' Physical and Mental Health

To reduce the spread of the virus, Bian proposed that mealtime should be arranged according to grades and classes, and the school hospital should implement a 24-h duty system. She also checked students' daily health conditions and recorded each students' information carefully, including temperature changes, symptoms of physical discomfort, medications, and the details of medical consultations. When students had suspected symptoms or other serious health problems, she would immediately contact the hospital for treatment and report to the leaders in the city for consultation. She would also accompany the sick students to the hospital and care for them until they recovered. Bian treated her students so much like children, that they began calling her “Mom Bian”.

Furthermore, Bian, together with school doctors, conducted a variety of activities such as campus broadcasting to assist students in correctly treating the epidemic and managing negative emotions. Thanks to the efforts made by teacher Bian and other teachers, the students’ physical and mental health were well-protected.

5.3.3 Allowing Students to Eat Well, not just Eat Enough

Food supplies were short during the COVID-19 pandemic. To guarantee the nutrition of students and boost their immune resistance, Bian managed to obtain sufficient nutritious ingredients, including meat and vegetables. Due to the epidemic control, the vehicles transporting vegetables were not allowed to drive into the school, which was troublesome. To solve the problem, Bian decided to receive and count the supplies at the school gate, bring them to a storage area, perform a quarantine inspection, and then carry the safe ingredients to the food processing room. There were more than 500 people in the school at that time. It was extremely hard to transport and inspect the ingredients needed by so many people. In addition, Bian wanted her students to eat well, not just enough. To do so, she organized canteen staff meetings many times to emphasize the significance of food safe and often asked her students what they wanted to eat. A student at the school named Bai said, “every time we told teacher Bian what we wanted to eat, we could eat the food the next day!” (*ibid*).

5.3.4 Enriching Students’ Learning Life

In addition to taking care of the students’ health and nutritional needs, Bian assumed the role of classroom teacher and subject tutor. She insisted on offering a variety of interesting physical education lessons for the students despite the fact that she was very busy. She hoped to strengthen students and improve their quality of life during this special period by offering physical education lessons.

5.3.5 The Most Beautiful Educator Combating COVID-19

Since the outbreak of the COVID-19, Bian has worked conscientiously, with little rest. It is her hard work that brings safety and happiness to the students. Nobody can count how many times she has patrolled the school, how many questions she has answered for students, and how many calls she has received.

“I often felt tired, both physically and mentally. At that time, I rarely got more than 6 h of sleep per day. Sometimes, I really wanted to go back to my room and just lie in the bed for a while. However, every time I looked at the students and their smiling faces, I would feel energized, and everything was worthwhile." (*ibid*).

Later, China Education Daily commented on Bian's deeds, and she was awarded "zhanyi zuimei jiaoyu ren (the most beautiful educator combating COVID-19)" (*ibid*). Her selfless spirit and sincere dedication to her students were highly praised. Importantly, like her, many other educators in China also helped safeguard and support students during the COVID-19 pandemic.

6 Latest Research

6.1 General Overview

High school education plays an important part in the national education system. The purpose of this section is to investigate research trends at the high-school level in China through the analysis of journal articles on China National Knowledge Infrastructure (CNKI), which is the world's largest Chinese journal database. Publication dates are restricted from January 01, 2012 to June 20, 2022. An electronic search is carried out using the keyword "high school". Finally, 70,106 articles are identified. Figure 11 presents the distribution of the major research topics.

It can be seen from the Fig. 11 that the most researched subjects are high school math, followed by high school Chinese, high school English, and high school physics. In addition to course subjects, the first topic that was researched in general is core competency, followed by teaching strategy.

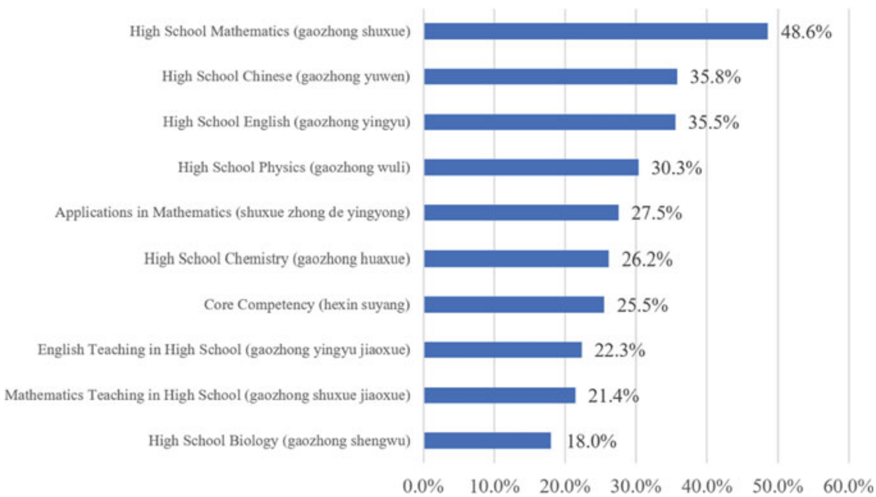

Fig. 11 Major research topics in CNKI from 2012 to 2022. *Source* Compiled from search result from CNKI

6.2 Research Topics

6.2.1 Core Competency

The term core competency (*hexin suyang*) first appeared in *Core Competencies for a Successful Life and a Well-Functioning Society* proposed by OECD in 2003. The research on core competencies in China began in 2013 when Xin et al. (2013) published an article about the model construction on core competencies of students in compulsory period. This research topic was soon extended to high school level in 2015, and the number of relevant research studies increased significantly in following years. One important factor behind the phenomenon is that MOE (2014) asked for opinions on comprehensively deepening curriculum reform (*kecheng gaige*) and emphasized the urgent need to propose a system of core competencies for student at all levels of school.

In 2016, China specified the key abilities that students should possess to meet the challenges in the twenty-first century. The implementation of core competencies requires the systematic transformation of teaching beliefs, practices, and behaviors. In response to the national education policy, researchers begin to develop policy-oriented evaluations on system of core competencies in specific subjects. Li et al. (2021) proposed an evaluation framework of Chinese core competencies in high school. It consists of four constructs, including language construction and use, thought development and enhancement, aesthetic appreciation and creativity, cultural heritage and understanding. Rather than focusing on subject knowledge, the framework emphasized student's deeper understanding of the nature of Chinese subjects.

The teaching community is also dedicated to developing new teaching strategies aligned with the concept of core competencies in practical teaching (Liu & Huang, 2022; Zhang, 2017). Take science courses as an example: Guo and Yao (2016) designed a model of science instructional design based on learning progression. It includes five stages of teaching targeted at the cultivation of big scientific concepts: analysis, design, development, implementation, and evaluation (ADDIE). The instructional design model is shown to be effective through comparing the experimental group's and control group's knowledge understanding and ability to explain scientific phenomena.

6.2.2 Curriculum Reform

Curriculum reform is always one of the leading themes in high school education. Many districts in China have long been criticized for the problem of exam-oriented education for high school students. With the rapid development of the global education ecosystem, there is a consensus on the importance of reconsidering the traditional method of teaching. Given the negative impact of exam-oriented education on students' long-term development, Chinese government has put great efforts on transforming the objectives of teaching and learning, the standards of the curriculum, the structure of the curriculum, the management of teaching evaluation, and the development of teaching materials.

Researchers utilize the opportunity to reflect on the progress which China has made on curriculum reform throughout the years (Bai & Ma, 2019). Other researchers compare curriculum reform practices across countries, such as comparisons with the U.S. (Lu & Qian, 2013) and the U.K. (Qian & Wang, 2014), to highlight current calls for improving high school curriculum reform and to suggest what further research is needed. Key needs include increasing the academic curriculum and integrating vocational education into the ordinal high school curriculum.

The transformation of teachers' roles in classroom is another key issue. The shift from teacher-centered instruction towards student-centered instruction is highly appreciated (Yu, 2014; Zhang, 2014). Teachers used to be the sole authority holders in the classroom, but now they are seeking to play multiple roles as lecturers, coaches, and facilitators for ongoing improvement of teaching quality. Teachers do not just implement the teaching content as it is. Instead, they are the planners and developers of the curriculum. The responsibility of organizing lesson plans, finding classroom resources, facilitating team collaboration, and evaluating the learning outcome largely falls upon teachers. Researchers are investigating teachers' transformation and helping them change in effective ways.

6.2.3 Well-Rounded Education (*Suzhi Jiaoyu*)

The term "qualities" (*suzhi*) is a core concept in Chinese education and remains difficult to define in English. In short, it refers to the consistent quality structure that results from knowledge internalization, innate abilities, and physiology (Pang et al., 2020). Well-rounded education is the educational ideal behind curriculum reform. Instead of the one-sided pursuit of test scores and higher promotion rates, the goal of well-rounded education is to cultivate people who have a well-rounded development of ethics, intellect, physique, aesthetics, and labor for the society and country. While government views education as an investment to promote global competitiveness, the implementation of well-rounded education has been seen as a national strategy for sustainable education. Chinese authorities issued the first official document on well-rounded education back to 1999 and numerous reform directives have been published since then. As a result, high school student's qualities in arts (Wang, 2017), information (Wu et al., 2012), and labor (Zhang, 2020) are increasingly valued by researchers. Physical education (P.E.), music, and labor education are considered as important as other subjects such as Chinese language arts, math and English language.

Qualities is strongly influenced by one's educational background and social environment. However, many high schools remained committed to the original examination-oriented education because university admissions largely depend upon test scores. The reform of higher education enrollment policy is another hot topic under the background of well-rounded education. To be better in tune with education reform, the evaluation of students should highlight the concept of quality orientation.

Dong et al. (2019) highlighted the current practice of the talent selection function in Shanghai is the first to pilot the new college entrance examination reform. Students are admitted to college based on their overall qualities, which include moral development, academic performance, physical and mental health, artistic abilities, and innovative literacy (Shanghai Municipal Commission of Education, 2018). Although there is controversy about how to quantify student qualities, how to ensure the authenticity of the information, and whether it will cause new unfair educational opportunities, it is still a step towards helping schools change their practices and achieve well-rounded education.

6.2.4 Innovative Literacy

Innovative literacy refers to the ability of a person to utilize different forms of materials to draw accurate conclusions and scientific deductions with the aim of creating a novel and original product (Erdogan et al., 2013). Since innovative literacy is an essential quality in college admissions as mentioned before, high school education should equip students with the innovative knowledge and skills to deal with real-life challenges.

To encourage students' innovative literacy, maker education has become a popular topic in science, technology, engineering, and math (STEM) fields. The trend of maker education first emerged in the U.S. In maker education, students are encouraged to design, make, create, and modify objects towards a specific goal outside the formal classrooms (Tofel-Grehl et al., 2021). Open-access environments called "makerspaces" refer to spaces for creation and knowledge exchange among members (Saorín et al., 2017). In 2015, China's former Premier Li Keqiang toured Shenzhen's Chaihuo makerspace and praised makers as the driving force behind China's economic growth. The cultivation of innovative talents has become an important mission and the ideal of maker education has been spread around 2017. Current researches are focusing on how maker education should be designed to create student-centered learning that maximizes students' interest and engagement (Liu, 2017; Mi & Wang, 2019; Yang & Ruan, 2021). With advanced technology such as wireless technology and virtual reality (VR), teachers are able to create an innovation makerspace and fully stimulate students' interests in learning. However, efforts to bring maker education into high schools are still not enough. More research on its efficacy is needed.

Project-based learning (PBL) and team-based learning (TBL) are also applied with the aim of developing students' innovative literacy in all subjects. PBL is a pedagogical approach that engages students in various subjects through a project. Interdisciplinary teaching allows students to gain a more systematic understanding of various subjects. PBL and TBL have been demonstrated to be effective for increasing students' engagement and scaffolding learning to meet the unique needs of all students (Quan et al., 2019). Involving students in projects improves their collaboration and communication skills (Yu, 2018), which are highly sought-after in innovative literacy.

6.2.5 AI-Enhanced Education

Various research in the field of education and psychology has suggested that learning outcomes are associated with learner's personality, preferences, motivation, and other characteristics. Educators are thus encouraged to provide personalized instruction adapted to students' learning styles, but the shift from "one-size-fits-all" towards a student-centered instructional mode is not easy (Zhang et al., 2020). Institutions are turning to new technologies to address this urgent need. With the rapid development of technology, adaptive learning, learning analytics, and virtual assistance are increasingly viable as an alternative to traditional static instruction in hope of addressing students' variation (Wauters et al., 2010).

Take adaptive learning as an example. It can track student progress and make changes to the curriculum at any time (Becker et al., 2018), empowering students with more control over their learning content and pace (Dagger et al., 2005). Adaptive learning has proven its great potential to improve learning performance and engagement worldwide. It has received wide attention in China since 2015. Since then, online learning has encountered several problems including low retention rate and poor self-regulation. While adaptive learning is based on the idea that technologies are able to learn and modify the materials in response to student performance, it possesses the capacity to solve existing problems of online learning. As one form of personalized learning, adaptive learning is still at its infancy in China. However, even at the early stage, adaptive learning still offers educational institutions new opportunity to change classroom routines. In many cases, the results of adaptive learning systems are positive. For example, Yixue Squirrel AI is one of the first adaptive learning systems in China. Since its establishment in 2016, Yixue has collaborated with 200 public schools across China for math, English language, physics, Chinese language arts, and chemistry serving more than100,000 users (Yixue, n.d.). It uses diagnostic pre-assessments, differentiated instruction, high-quality learning content and immediate feedback (Li et al., 2018). Students gain greater success with Yixue Squirrel AI than traditional instruction (Cui et al., 2018; Li et al., 2018). Wang et al. (2020) also showed its usefulness compared to small-group classroom instruction.

Generally speaking, AI-enhanced education appears to be on its way to serve the broader educational practice for personalized learning. MOE (2012) demonstrated that "personalized learning information and environment should be provided for each student". They further announced the list of experimental zones to explore new instructional mode with IT (MOE, 2020d). However, technology alone does not yield improved learning outcomes. The effective implementation of adaptive learning calls for more attention and effort from institutions, educators, and other stakeholders to figure out the best educational practices.

7 National Policies

7.1 Basic Policies

In 2011, China achieved universal access to compulsory education. The strategic importance of high school education was further emphasized, and the high school education in China has entered a period of accelerated development. Over the past decade, the Chinese government has issued a number of policies to promote the development of high school education in China. The basic education policies are as follows (see Table 8).

7.2 Key Policies

7.2.1 Enrollment Reform (*Zhaosheng Gaige*)

MOE (2016) issued *Guidelines on Further Promoting the Reform of School Examination and Enrollment System in High Schools*, pointing out that there are problems with the enrollment of high school students in China, including the over-emphasis on exam scores, the narrow range of scoring subjects, and the unequal access to high-quality high schools. To solve the problems, MOE has promoted the reform of enrollment system in high schools. The key points are as follows:

Reforming High School Academic-level Examination. To encourage students to learn every subject carefully, MOE (2016) advocated that all subjects (Chinese language arts, math, foreign languages arts, politics, history, geography, physics, chemistry, biology, P.E. and health, music, art, information technology, etc.) specified *the Experimental Program of Compulsory Education Curriculum* should be included in the scope of the junior high school academic level examinations.

MOE (2016) also stressed the need to reform scoring methods. In addition to Chinese language arts, math and foreign languages, other subjects should also be considered as scoring subjects and the scoring methods should consider various factors including study stress, the balance between subjects, and students' selectivity. Furthermore, it is suggested to adopt grading system instead of raw scores to avoid excessive competition.

Improving Overall Quality Evaluation System. To further promote students' well-rounded development and healthy growth, the education departments and high schools have continuously improved the overall quality evaluation system and actively explored the enrollment mode based on it. According to MOE (2016), local governments should improve the systems according to the following points (see Table 9).

Improving Quota Allocation Implementation in High-Quality High Schools. To promote the balanced development of compulsory education, the reform of high

Table 8 Key contents of the basic policies

Aspects	Policies [year]	Main contents
Universal access to education	*Action Plan for Universal Access to Upper Second Education (2017–2020)* [2017]	By 2020, the gross enrollment rate of high schools in all provinces should reach more than 90%, and special groups such as students from poverty-stricken areas in the central and western regions, students with financial difficulties, disabled students, and relocated children of migrant workers should receive more attention[a]
Safeguard mechanism	*Action Plan for Universal Access to Upper Second Education (2017–2020)* [2017]	Local governments should improve the allocation system of educational expenditure per student
		Tuition fees can be waived for students with financial difficulties
Teaching conditions	*Action Plan for Universal Access to Upper Second Education (2017–2020)* [2017]	Eliminate large classes and reduce super large schools
		Strengthen the reconstruction of school buildings, libraries, and sports facilities in schools in impoverished areas, to help these schools meet the basic needs of teaching
	Guidelines on Promoting the Reform of Educational Methods in High Schools in the New Era [2019]	Schools are encouraged to construct innovation laboratories and activity rooms, and provide information equipment and other advanced facilities
Teacher building	*Action Plan for Universal Access to Upper Second Education (2017–2020)* [2017]	Schools should establish inter-school teacher shifting systems to ensure teacher sufficiency
	Guidelines on Promoting the Reform of Educational Methods in High Schools in the New Era [2019]	Innovate teacher training methods; focus on improving teachers' ability to implement course reform; guide students' career development; implement classified class teaching
	Action Plan for the Development and Improvement of County High Schools in the "14th Five-Year Plan" [2021]	Establish training programs for excellent teachers in underdeveloped regions
Talent cultivation	*Action Plan for Universal Access to Upper Second Education (2017–2020)* [2017]	High schools are encouraged to develop their own characteristics
	Curriculum Plan of High School and Curriculum Standards of Chinese and Other Disciplines (2017) [2018]	High school curriculum reform (This policy will be introduced in the ensuing paragraphs.)

(continued)

Table 8 (continued)

Aspects	Policies [year]	Main contents
	Guidelines on Promoting the Reform of Educational Methods in High Schools in the New Era [2019]	Strengthen overall quality training and improve overall quality evaluation systems
		Schools should attach importance to students' career development guidance
Examination and enrollment	*Implementation Guidelines on Deepening the Reform of Examination and Enrollment System [2014]*	Improve the distribution of enrollment plans to increase the college entrance examination admission rate in underdeveloped regions and populous provinces
		Reform examination content, improve academic-level examinations, and standardize the overall quality evaluation of high school students
		2014 marks the beginning of the college entrance exam reform

Source MOE et al. (2017), MOE (2018, 2021e), the State Council (2014, 2019c)
[a]In some regions across the globe, high school education is publicly funded. Although China's high school education is not free in general, the country has been working on decreasing the fees for high school students

Table 9 Key points in establishing an overall quality evaluation system

Aspects	Main contents
Evaluation contents	The evaluation contents should include students' moral characters, academic performance, physical and mental health, artistic quality, and social practice. Clarify approaches should be developed to evaluate students
Evaluation materials	The materials used in the comprehensive evaluation should be put into an electronic system. The materials include objective data (for example, grades, and physical test results) and subjective statements (including self-introduction, representative experiences and research study reports). Schools and other institutions should enter the data into the electronic system on time. Students should sort out their materials on a regular basis, write statements on time, and be responsible for the authenticity of their submissions
Evaluation procedures	High schools should specify the methods for using materials in the electronic system and the process for overall quality evaluation, and publish them in advance
Supervisory measures	Except for personal private information, all information stored in the electronic system should be made available to the public for supervision. It is necessary to establish mechanisms (e.g., an accountability system) to ensure the objectivity and authenticity of the evaluation system

Source MOE (2016)

Table 10 A glance at the local policies on quota allocation

Provinces/ Cities	Policies
Shaanxi province	At least 50% of the enrollment quota of provincial model high schools will be allocated to junior high schools in the region, and appropriate preference will be given to rural junior high schools
Fujian province	No less than 50% of the enrollment quota of the high-quality high schools will be allocated to each middle school, and the targeted enrollment quota is tilted to rural middle schools
Shanghai	The number of students enrolled through quota allocation will account for 50–65% of the total enrollment plan of Shanghai high-quality schools
Hebei province	The enrollment ratio of "quota to school" of high-quality high schools should reach 80%

school enrollment system attaches great importance to implementing the quota allocation of high-quality high schools. According to MOE (2016), junior middle schools in the region should get a reasonable allocation of enrollment quota from high-quality high schools. Besides, the high schools in urban areas should allocate some enrollment quota to the junior middle schools in rural areas.

Several local governments have released the policies on quota allocation. Table 10 displays the policies in a number of provinces and cities (Fujian Provincial Department of Education, 2018; Hebei Provincial Department of Education, 2018; Shaanxi Provincial Department of Education, 2017; Shanghai Municipal Commission of Education, 2021).

Many other provinces and cities are also actively working on improving the enrollment ratio of quota allocation. It is expected that several provinces will achieve 100% enrollment through quota allocation in high-quality high schools by 2023, which will affect more students and parents.

7.2.2 College Entrance Examination Reform (*Gaokao Gaige*)

In 2014, the State Council issued *Implementation Guidelines on Deepening the Reform of the Examination and Enrollment System*. Since then, the most comprehensive, systematic, and profound round of college entrance examination reform in China has begun, in response to long-standing problems of over-emphasizing scores in China's college entrance examination.

According to MOE (2021f), Shanghai and Zhejiang, as pilots, launched the college entrance examination reform in 2014. Three years later, the reform's first batch of high school students sat for the college entrance examination. In the same year, Beijing, Tianjin, Shandong and Hainan announced to join the reform. In 2018, eight provinces (Hebei, Liaoning, Jiangsu, Fujian, Hubei, Hunan, Guangdong and Chongqing) kept up with the pace of reform, which also means that the college entrance examination reform, starting from the Eastern regions, has expanded to the Central and Western regions of China, representing a new stage. After 2019, 16 provinces and cities including Anhui, Sichuan, Henan, Shanxi, Heilongjiang, Jilin and Inner Mongolia followed the reform. With the continuous advancement of the reform, the new college entrance examination reform has been gradually implemented nationwide. The three major measures of the college entrance examination reform will be introduced below.

Adjusting Examination Subjects. Chinese language arts, math, and English language are required subjects of college entrance examination. In addition to them, students must select other subjects as scoring subjects in the exam. Before the reform, students had only two options: politics, history, and geography or physics, chemistry, and biology. Students were thus divided into "science students" and "arts students". This subject selection system is also known as the "Division of Arts and Science".

The college entrance examination reform abolished this subject selection system, giving students more autonomy and flexibility in subject selection. Students can choose freely from politics, history, geography, physics, chemistry, biology, and technology. There are mainly two types of policies for selecting subjects, "3 + 3" and "3 + 1 + 2" (Table 11).

Reforming Scoring Methods. The scores for Chinese language arts, math, and English language will be added to the total scores directly, while the results for the other subjects will be processed as converted scores. Exams for the selected subjects are broken down into "passing exam (pass/fail)" and "grading exam (A/B/C/D/E)". The "grading exam" is only open to the students who have successfully completed the "passing exam". Scores for the selected subjects will be generated based on students' ranks. In order to make it easier to understand, the method used in Beijing is presented as an example (see Table 12).

Implementing College Admission with "two base + one reference". To reverse the value orientation of "score-only", China's college entrance examination reform adopts the "two base + one reference" mode in the enrollment process. The "two base" refers to college entrance examination score and the score of academic proficiency test (the "passing exam" and the "grade exam" mentioned above). "One reference" refers to overall quality evaluation. The State Council (2014) clearly points out that it is necessary to improve the overall quality evaluation system for high school

Table 11 Two types of policies for selecting subjects

Modes	Examination subjects	Target regions
"3 + 3"	3: Chinese, math and English	Zhejiang, Shanghai, Beijing, Tianjin, Shandong, Hainan
	3: Any three of the following subjects: politics, history, geography, physics, chemistry, biology, technology	
"3 + 1 + 2"	3: Chinese, math and English	Hebei, Liaoning, Jiangsu, Fujian, Guangdong and other 15 provinces/cities
	1: physics or history	
	2: Any two of the following subjects: chemistry, biology, politics, geography	

Table 12 Scoring method for selected subjects in Beijing

Grades		Ranking ranges	Corresponding scores
A (15%)	A1	1%	100
	A2	2%–3%	97
	A3	4%–6%	94
	A4	7%–10%	91
	A5	11%–15%	88
B (35%)	B1	16%–21%	85
	B2	22%–28%	82
	B3	29%–36%	79
	B4	37%–43%	76
	B5	44%–50%	73
C (34%)	C1	51%–57%	70
	C2	58%–64%	67
	C3	65%–71%	64
	C4	72%–78%	61
	C5	79%–84%	58
D (15%)	D1	85%–89%	55
	D2	90%–93%	52
	D3	94%–96%	49
	D4	97%–98%	46
	D5	99%	43
E	E	Last 1%	40

Source Beijing Municipal Education Commission (2018)

students and apply overall quality evaluation into college admission. The overall quality evaluation system for high school students is quite similar to the one for junior high school students, which has been introduced in the previous chapter. One significant difference is that high school students' evaluations highlight students' performance of social responsibility, innovation spirit, and problem-solving skills, in addition to moral character, academic success, physical and mental health, artistic excellence, and social practice.

7.2.3 Curriculum Reform

Basic courses play a key role in education. In 2003, MOE issued *Experimental Draft of the Curriculum Plan and Curriculum Standards for High Schools*, which has guided the curriculum reform in high schools for more than 10 years, and has established a high school curriculum system suitable for China's national conditions, making a positive contribution to the improvement of the education quality in China.

However, with the development of economy, science and technology, new requirements for talent cultivation have been constantly put forth. The original curriculum system needs to be improved.

In 2013, MOE launched the plan for high school curriculum revision, with a view to revising the current curriculum plan and curriculum standards into programmatic teaching documents that not only conform to China's actual situation, but also have an international perspective, so as to build a high school curriculum system with Chinese characteristics.

In 2018, MOE issued *Curriculum Plan of High School and Curriculum Standards of Chinese and Other Disciplines (2017).* Compared with the curriculum plan and curriculum standard issued in 2003, the revised plan and standard mainly have the following changes.

Changes of Course Plan. The three major changes in course plan will be introduced below.

- Clarify the orientation of high school education in China. This revision aims to change the tendency of over-emphasizing scores, and re-affirms the goal of China's high school education is raising students' overall quality by emphasizing the development of core competencies and the sense of social responsibility, as well as the capacity for lifelong learning and self-motivated development.
- Optimize course structure. This revision adjusts the courses to mandatory courses, optional mandatory courses, and optional courses. It aims to ensure an academic foundation for all students while giving students more chances for personal growth. In addition, the new curriculum plan also adapts the credit system in high school to the change in the course structure.
- Strengthen the supporting system for curriculum implementation. To adapt to the changes brought by the college entrance examination reform, the revision further defines the responsible parties in curriculum implementation and their responsibility requirements.

Changes in Curriculum Standards. The three major changes in curriculum standards will be introduced below.

- Specify the core competencies for each discipline. MOE (2014) proposed to refine the requirements for talent training and raised two questions: What kind of students do China need? How to cultivate the students? In this context, the core competency system came into being. It defines the necessary characteristics and skills for students to adapt to the development of society, and has become the core guidance for high school instruction. In order to better cultivate students' core competencies, the new curriculum standard has specified core competencies for each discipline. Take English as an example (Table 13).

- Update teaching contents. Traditional Chinese culture should be integrated into teaching and learning, in order to strengthen the ideological nature of the courses; present new achievements in economic, political, cultural, scientific, technological, social and ecological development, so as to cultivate students' spirit of

Table 13 Core competencies for English

Core competencies	Descriptions
Language proficiency	The ability to understand others and express oneself in social situations by listening, speaking, reading, watching, and writing
Culture character	The ability to understand both Chinese and foreign cultures
Thinking quality	The ability to think logically, critically, and creatively
Learning ability	The ability to improve English learning efficiency by adjusting strategies and broadening learning channels

Source MOE (2018)

keeping pace with the times; pay attention to the internal connection between knowledge, as well as the interdisciplinary connection among disciplines, so as to strengthen the integrity of teaching contents.

- Develop academic quality standards. Academic quality standards define students' specific performance at different core competency levels. With the help of the standards, students can conduct self-tests and achieve self-improvement. Teachers can better understand students' performance and cultivate students' core competencies. Academic quality standards can also strengthen the relationships between teaching, learning, and evaluation by serving as a crucial foundation for formative assessment, academic level exams, and admission exams.

7.2.4 The Latest Changes in Curriculum Reform

MOE has published a new version of curriculum plan and curriculum standards in 2022. The fundamental difference between the new and the old is a stronger emphasis on the necessity to merge the primary and junior high school curricula and to increase the connections among different learning stages, so as to establish a solid basis for high school education.

8 Summary

This chapter shows the development and achievements of China's high school education in recent years through data analysis, indicators building, case studies, storytelling, research reviews and policies combing. After years of reform, China's high school education has taken on a new look. It mainly has three characteristics.

These reforms have profoundly changed the ways of cultivating talents. Over the past 10 years, China's high school education has implemented many reforms including the curriculum reform, the enrollment reform, and the college entrance examination reform. The textbooks, curriculum structure, teaching contents, teaching methods, and evaluation systems have all been updated as part of the reform process, which have significantly changed how high school education is delivered in China. In addition, high schools in China have actively explored how to utilize IT to optimize teaching methods. Some, for example, have begun to adopt AI-powered educational systems to make teaching more effective and intelligent.

These reforms have brought more attention to the breadth of student development. Many high schools in China (e.g., the High School affiliated to Fudan University) have developed new curriculum systems to guide students in acquiring extensive knowledge in various fields. Furthermore, the establishment of overall quality evaluation systems encourage students to develop holistically rather than only focusing on examination scores.

Increasing emphasis has been laid on promoting equitable and balanced education. Principal Zhang Guimei founded the first all-girl free-education public high school in China in order to reduce the educational inequity caused by gender differences and regional differences. The quota allocation policy in high school enrollment is designed to improve the entrance opportunities for disadvantaged groups (e.g., students from the middle schools in rural areas). The high school-centered education groups (e.g., Jianping Education Group) have effectively promoted a more balanced distribution of high-quality educational resources. Other measures are also used to promote education equity in China, with the goal of eliminating educational injustice caused by gender differences, inter-school differences, urban–rural differences, and regional differences.

In recent years, the development of high school education in China has made many breakthroughs and entered a new stage of development. However, there are still some inadequacies. For example, China's fiscal expenditure on high school education has nearly doubled in the past decade, but the total expenditure per student is still lower than the international average. The recent press conference held by MOE (2022) also shows that more attention will be paid to the development of high school education in the future, to meet the challenges brought by the unprecedented changes in the world.

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Chapter 5
Undergraduate Education (*Benke*) in China

Liu Li, Wang Qi, Li Yujie, Zhao Yiwei, Dong Yanbang, and Xu Yiqing

Abstract Undergraduate education plays a fundamental role in China's higher education reform in the last four decades. Great progress has been made in undergraduate enrollment, quality, and effectiveness. Most recently, Chinese higher educational reforms have focused on developing world-class undergraduate education with Chinese features. This chapter presents an overall picture of the Chinese undergraduate education sector and analyzes its development and performance through an international comparative lens. It then provides case studies of best practices and inspiring stories of teaching excellence. This chapter also reviews national policies and existing literature on undergraduate education by Chinese scholars.

Keywords World-Class undergraduate education · Quality and performance · Undergraduate teaching and learning · Teaching excellence · Policy highlights on undergraduate education

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1 Introduction

The modern concept of undergraduate education first appeared in *University Ordinance* (*Daxueling*) issued by the Ministry of Education of the Republic of China in 1912, "Once completing the foundation year and passing all the examinations, students will be granted graduation certificates and will be admitted to undergraduate studies" (Zhu & Yao, 1993). In 1985, Ma Jixiong, a well-known expert on comparative and international education in China, used a Chinese perspective to analyze undergraduate programs relative to and beyond pre-college preparatory programs, and the specialized courses offered to students (Ma, 1983). According to the International Standard Classification of Education (ISCED) published by UNESCO, undergraduate programs are the first stage of tertiary education, and entry into these programs normally requires successful completion of senior secondary school or equivalent programs. These programs, traditionally offered by universities or equivalent tertiary education institutions, provide students with intermediate academic and/or professional knowledge, skills, and competencies with a duration of four or more years. Higher education in China consists of undergraduate and postgraduate education. Undergraduate education includes education in both academic and vocational routes and is considered the major sector in Chinese higher education (Huang, 2017). Regular higher education is the academic route and offers four-year programs leading to bachelor's degrees. Tertiary vocational education is the vocational route, consisting of both four-year bachelor's degree programs and three-year associate degree programs. This chapter's analysis of undergraduate education mainly focuses on the academic route programs offered in the regular higher education.

1.1 History and Status of Undergraduate Education in China

1.1.1 History of Undergraduate Education in China

The modern Chinese undergraduate education has a history of more than 100 years, including three stages, that is, forming, rapid development and quality-driven development stages.

Forming Stage. Modern undergraduate education in China began in the late Qing Dynasty and early Republican era. *Presented School Regulation* (*Zouding Xuetang Zhangcheng*) issued by the Qing government in 1904 defined undergraduate education as the second of three-level university education (Qu, 1993). In 1912, the Ministry of Education of the Republican government announced the *University Ordinance*, which established seven undergraduate education subject areas (i.e., arts, science, law, commerce, medicine, agriculture and engineering) and furthered its duration and required courses in 1913 (Li, 1997). The *Dictionary of Chinese Education* (*Zhonghua Jiaoyu Cidian*) issued in 1928 explained that undergraduate education and its courses were designed by grades, and its content was above preparatory programs, so that graduates completing preparatory programs would be able to enter the specialized professional learning, e.g., teacher education and university degrees (Qu & Wang, 2015). Ever since, undergraduate education has been officially regarded as a major level of university education.

Rapid Development Stage. Undergraduate education underwent a series of changes since the founding of the People's Republic of China. After the opening-up in 1978, with the deepening of the ideological emancipation movement and the continuous socio-economic recovery, undergraduate education was fully restored. It has been experiencing rapid development, especially since the national economic structural reform (Yang, 2004). In 1978, the Ministry of Education (MOE) reaffirmed that the objective of higher education institutions (HEIs) was to cultivate "specialized personnel" (*Zhuanmen Rencai*) rather than general workers (National Institute of Education Sciences, 1984). In 1985, *Decision on the Reform of the Educational Structure* pointed out that HEIs should be provided with more autonomy. As such, universities should have the right to adjust educational programs, formulate teaching plans and syllabuses, and prepare and select teaching materials, etc. (Central Committee of the Communist Party of China [CPC], 1985). In another policy document from 1992, the then National Education Commission (now MOE) explicitly proposed to expand subject areas and develop quality and capable undergraduate students (National Education Commission, 1993). In 1998, the MOE issued *Action Plan for Education Revitalization in the 21st Century* and proposed that by 2010 the gross enrollment ratio (GER) of higher education in China would reach 15% of students at school age (MOE, 1998). Since then, the scale of undergraduate education has witnessed a rapid growth.

Quality-Driven Development Stage. At the beginning of the twenty-first century, with the excellence initiatives (e.g., Projects 211 and 985) implemented in the higher education sector, undergraduate education in China entered its quality-oriented development stage. In 2006, the government launched a series of policy documents emphasizing the importance of cultivating top talents, developing quality assurance, building world-class undergraduate curricula and programs, and encouraging innovation and entrepreneurship, to enhance quality and standards of undergraduate education and move focus from quantity to quality in higher education expansion. The Double World-Class Project was implemented in 2015. Along with the *Guidelines on Accelerating the Development of High-Quality Undergraduate Education and Comprehensively Improving the Capacity of Talent Training* (hereafter *the 40 Guidelines on Higher Education Development in the New Era*), a macro guideline document on developing undergraduate education in 2018, the project reiterates the importance to form high-standard undergraduate education with Chinese characteristics and world-class standards by 2035. The project ultimately aims to provide strong support to develop a strong nation through higher education (MOE, 2018a). In 2018, MOE, Ministry of Finance (MOF), and National Development and Reform Commission (NDRC) jointly issued *Guidelines on Accelerating the Development of the Double World-Class Project*, which clearly defined the goal of developing world-class undergraduate education, emphasized the fundamental role and status of undergraduate education, made the development of world-class undergraduate education the essential task of the Double World-Class Project, etc. (MOE et al., 2018a). Ever since, undergraduate education in China has been marching toward the goal of achieving "world-class" status.

1.1.2 The Status of Undergraduate Education in China

From a global perspective, world-class universities tend to place undergraduate education at an important strategic position and make developing world-class graduates as an unchangeable goal of the universities. The thousand-year history of universities in the world also shows that undergraduate education lays the foundation for higher education development, and to some extent decides the progress of its country (Chen, 2018a). Since the beginning of the twenty-first century, refocusing on undergraduate education and launching teaching reforms have become common agendas for leading universities around the world, including Harvard, Stanford, and MIT. (Chen, 2018b).

In June 2018 at a national convention, MOE stressed that undergraduate education should be placed "at the center of workforce development, as the groundwork of university education, and at the forefront of education development in the new era" (Chen, 2018b). The term "undergraduate education as the foundation" (*Yiben Weiben*) summarizes its significant status in the Chinese higher education and its pursuit of academic excellence (MOE, 2018b). According to statistics on the 1,200 undergraduate institutions, the ratio of undergraduates to graduate students nationwide is 8:1, and 87% of students graduating are undergraduates (Chen, 2018b).

1.2 The Notion of World-Class Undergraduate Education

In the 2016 working meeting on teaching reform, MOE explicitly stated that world-class undergraduate education is the foundation and basic feature of world-class universities, and that developing world-class undergraduate education be included in the Double World-Class Project action plan (Ma, 2016). Further, 150 universities jointly issued *World-Class Undergraduate Education Statement* (also called *Chengdu Statement*) (MOE, 2018b) that advocated for nurturing top talent and developing excellence in undergraduate education. Arguably, the notion of "world-class undergraduate education" is derived from the Double World-Class Project context and has experienced a transformation from a top-down policy to intrinsic motivation within universities (Yang, 2021). While this term originates from the integral role of undergraduate education in promoting academic excellence, it is rooted in the fundamental problem that Chinese universities are relatively lagging behind the world's leading universities in terms of cultivating high-quality workforce (Zhou, 2019). To cater to the changing context of universities and their own development needs, various ideological transformation has been taking place throughout undergraduate education, including making interdisciplinary programs mainstream, emphasizing student-centered ideology, and confirming the strategic importance of developing excellence.

The goal of world-class undergraduate education is to pursue excellence in teaching and learning (Zhang, 2019). It means high-standard and high-quality educational activities under specific goals, promoting quality culture, and enhancing overall quality in undergraduate education and workforce development (Yang, 2021). In the Chinese context, world-class undergraduate education should follow the four principles of "return to common sense, return to the essence, return to the original heart, and return to the dream", build a general pattern of "three-holistic education" (*sanquan yuren*),[1] and understand rationales of higher education development and talent growth. Within such a system, students are encouraged to study hard, and teachers are inspired to teach and nurture well-round graduates for nation building (MOE, 2018a).

Based on the above context, this chapter first depicts the development of China's undergraduate education and analyzes its performance through key indicators from an international comparative perspective. It then provides case studies to illustrate the exploratory paths of Chinese universities and share inspiring stories of teaching excellence, particularly on the aspects of talent development, quality assurance, and innovation and entrepreneurship. The chapter lastly reviews policies on Chinese undergraduate education and related research by Chinese scholars, to reflect its policy trends and theoretical thinking.

2 Highlighting Data

2.1 Size and Scales

In the past decade, the Chinese higher education system has been continuously and rapidly expanding its undergraduate sector, providing strong intellectual support for its socio-economic development. Since the economic reform and opening-up, China has trained more than 60 million undergraduate students, who have become central to China's socio-economic development (Shi, 2018).

The total number of undergraduate students reached 19.06 million in 2021, an increase of more than 40% from 2011. The total undergraduate admission has also grown steadily, with an additional 4.49 million students admitted in 2021, which

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[1] "Three-holistic education" means education provided by "whole" community, through "whole" process and with "well-round" focus. In other words, everyone in the community engage in teaching and learning, including students themselves, teachers, school staff, and other community members; teaching and learning happens any time (throughout the school years) and any place (all aspects of school life, including teaching, management, and financial support to students); and teaching and learning should focus on comprehensive effectiveness and include moral education, intellectual education, physical education, aesthetic education, labor education and other comprehensive education.

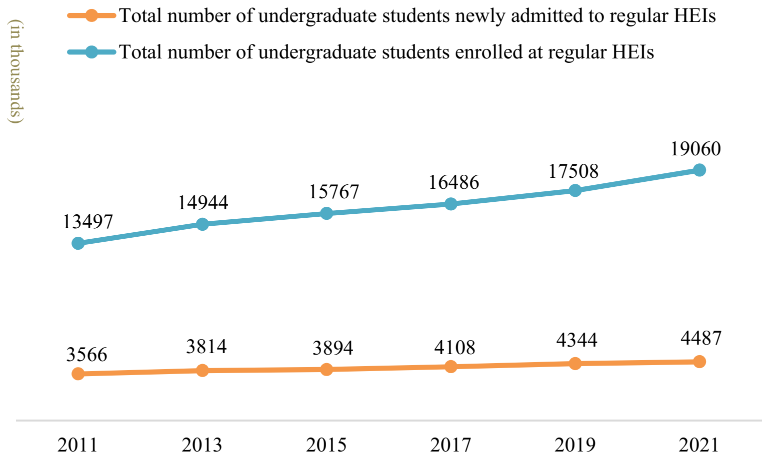

Fig. 1 Number of undergraduate students at regular HEIs (2011–2021). *Source* Adapted from MOE (2021a)

seeks to keep pace with the growing public demand for university education (see Fig. 1).

A comparison with the world's major developed countries shows that, from 2014 to 2020, despite a slow decline each year, the total number of newly admitted undergraduates in the United States (U.S.) far exceeded those in other countries; China's undergraduate admission increased steadily and exceeded those in many developed countries; and the admission number in Japan and the Republic of Korea (ROK) exceed those in Germany, the United Kingdom (U.K.), France, Australia and the Netherlands (see Fig. 2).

In terms of institutional layout, there are five different types of undergraduate institutions in China, namely, universities pursuing world-class status, universities developing world-class disciplines, regular undergraduate universities, newly-established universities and colleges, and independent colleges (Fan et al., 2021). Among them, ordinary undergraduate colleges and universities have the largest enrollment volume, accounting for more than 40% of the total undergraduate enrollment in 2021, which is closely related to the enrollment plan of college entrance examination. In the past decade, the number of institutions training undergraduates in China has shown a steady growth, reaching 1,270 in 2021 (Fig. 3).

2.2 *Outline of Academic Disciplines*

In terms of academic disciplines at the undergraduate level, engineering science has the largest student enrollment, which advances the national strategy to develop manufacturing power. Overall enrollment and graduates of engineering majors in regular

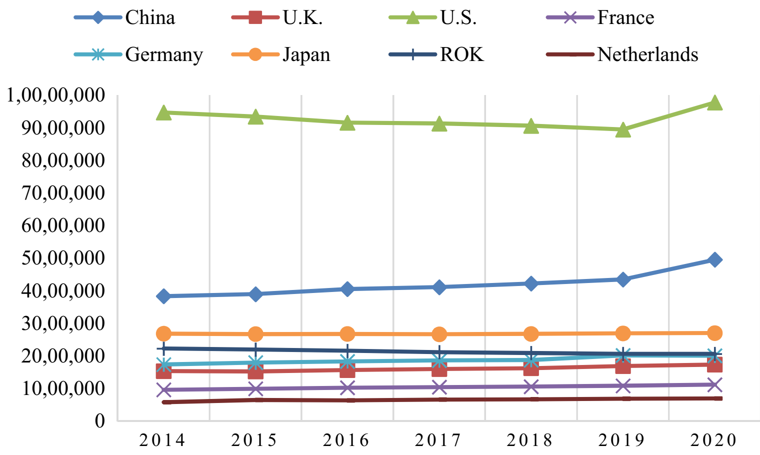

Fig. 2 Undergraduate admission in China and some developed countries (2014–2020). *Source* OECD (2021)

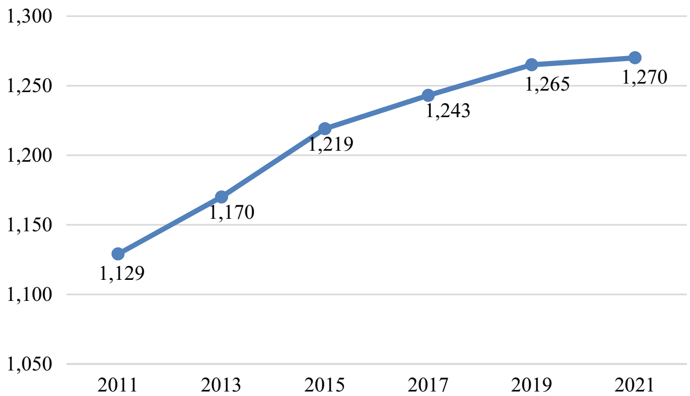

Fig. 3 Numbers of HEIs in China (2011–2021). *Source* Adapted from Fan et al. (2021), MOE (2022)

HEIs in China are much higher than those of other countries in the world and are three to five times higher than those of Russia and the United States which follow closely behind (Ding & Zhao, 2018). Information from MOE shows, with the largest scale of engineering education in the world, China had about 1.28 million freshmen students, an overall enrollment of 7.02 million students as well as 1.37 million new graduates from 18,822 engineering programs in 2020 (*ibid*). All the number for the above four aspects represent 1/3 of the overall national undergraduate volume. Meanwhile, China continues to make great efforts to improve the quality of undergraduate engineering education. Hoping to join the Washington Accord, China has been promoting program accreditation exercises and strengthening comprehensive reform in engineering education (MOE, 2018c). As of 2020, 1,600 engineering degree programs in 257 regular HEIs in China have been accredited and recognized, which cover 22 specialized engineering majors including machinery and instrumentation (MOE, 2021b). According to the Director of the Department of Higher Education at MOE, engineering education in China should contribute its expertise to the global stage and play a leading role in the development of engineering education in the world (Li, 2018).

Chinese student enrollments by academic discipline vary greatly from EU students. In 2018, one fifth (22%) university students studied business, administration or law. The second most common field of study was engineering, manufacturing, and architecture related areas, accounting for about 15.8% of total higher education students (Eurostat, 2020). Similar to EU countries, more than a quarter (25.5%) of university students study in the fields of business, administration or law in the U.S. (OECD, 2018).

2.3 Faculty Development

Overall, China has the largest number of full-time faculty in the world, but its student–teacher ratio is also high. By 2020, the number of full-time faculty at regular HEIs reached 1.61 million, with a growth rate of 3.8% from the previous year. However, when taking into consideration the large student body at Chinese universities, the student–teacher ratio is rather high. In 2020, the student–teacher ratio at regular HEIs in China was 18.6:1, among which the ratio is 18.1:1 at regular undergraduate institutions, and 19.1:1 at newly-established institutions. However, the ratio is less than 10 at world leading universities (Fan & Wu, 2019).

In recent years, three main trends have emerged in terms of faculty preparation and demographics: the number of faculty holding higher education degree has gradually increased; a growing number of faculty have international academic and work experience; and young faculty members are a major force in Chinese higher education. In 2020, 41.8% of the full-time faculty hold a doctoral degree, 3.57% increase from 2018. Of universities pursuing world-class status funded by the Double World-Class Project, 74.9% of their full-time faculty with doctoral degrees; this number rises to 81.5% for universities aspiring to be world-class (Fan et al., 2021). In 2020, more than 20% full-time faculty have studied, worked or visited overseas universities for at least one year. The number of professors and academics from prominent overseas universities teaching and researching in China has also increased significantly. Faculty members have increasingly embraced a global view and enhanced their intercultural skills. In terms of age, nearly 70% of the full-time faculty are junior (under 35) and young (between 36 and 45) faculty (*ibid*). This shows junior and young faculty members are now the major force in Chinese higher education, and it also suggests a favorable growth trend and huge potential in terms of faculty development.

2.4 Educational Expenditure

The expenditure on undergraduate education continues to increase, at a higher growth rate than that of many developed countries. Educational expenditure is a fundamental and strategic investment that supports the country's long-term development and lays foundation to a country's education (Fan & Wu, 2019). China's overall expenditure on higher education increased from RMB951.8 billion to RMB1,346.2 billion, with an average annual growth rate of 9.1% (see Fig. 4). When compared with developed countries' expenditures in 2015 and 2019 (2.1% increase rate for OECD countries and 1.9% for EU countries), China's expenditures on higher education increased much faster.

Comparing data in Fig. 4 and Table 1, it is clear that the government spending in higher education in recent years has slowed down in developed countries. Average educational expenditure in OECD countries is slightly higher than that of EU countries.

Funding for undergraduate education in China primarily comes from the national government, and efforts have been made to further diversify its funding structure. In terms of funding sources, national expenditure on higher education (equivalent to

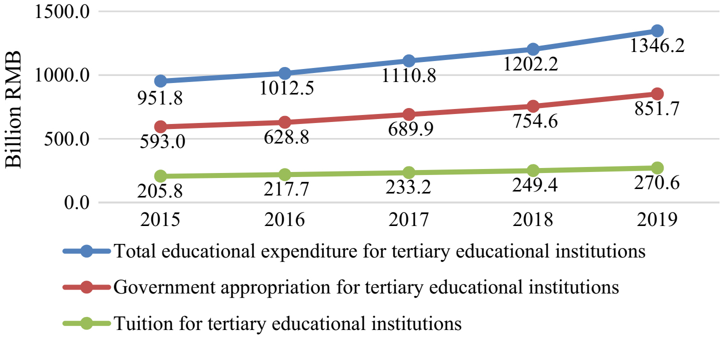

Fig. 4 Educational expenditure in Chinese higher education (2015–2019) (in RMB billion). *Source* MOE (2016, 2017, 2018d, 2019a, 2020a)

Table 1 Higher education expenditure in developed countries (in US$ million)

Year	2015	2016	2017	2018	2019
Average UN 20 countries	9,527	9,382	9,608	9,950	10,278
Average OECD 29 countries	12,472	12,493	12,866	13,234	13,546

Notes

1. To ensure year-to-year comparability, all spending measured in monetary terms (e.g., total expenditure) is adjusted by the Consumer Price Index (CPI) and measured in 2015 Constant Prices. All increase rate in this chapter is measured in Constant Prices
2. This table is compiled based on data from OECD and EU. Some countries' data are missing, including Bulgaria, Croatia, Cyprus, Malta, Romania, Ireland, and Denmark

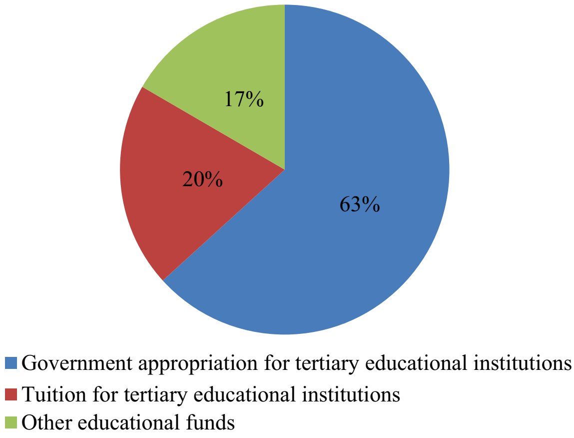

Fig. 5 Chinese higher education expenditure structure in 2019. *Source* MOE (2020a)

public expenditure in the OECD documents) is the main source of overall educational funding in China, accounting for more than 60%; while tuition fees (equivalent to household expenditure in the OECD documents) only account for 20% of the overall educational funding (see Fig. 5). Based upon Fig. 4, it can be argued that tuition fees have been increasing slowly, and the increase of national financial expenditure on education has led to the overall increase in educational investment.

2.5 Infrastructure

Infrastructure is fundamental to support teaching and research activities in undergraduate education. Figure demonstrates space utilization; laboratory facilities account for the largest space utilization with 5m^2 per student, followed by classroom facilities (4.5m^2 per student) and office and library facilities (about 2m^2 per student). The space for special use facilities and general use is relatively small: 1.5m^2 per student for specialized research rooms, 0.9m^2 per student for gymnasiums, and 0.3m^2 per student for assembly halls and meeting rooms (Fan et al., 2021). This suggests that the infrastructure at Chinese HEIs can meet the demand for teaching and research, but improvement is needed to expand general and athletic facilities.

As shown in figure, independent colleges and newly-established universities provide the largest classroom space per student, followed by regular undergraduate universities, universities pursuing world-class status, and universities developing world-class disciplines. Conversely, in terms of laboratory facilities and special research rooms, universities pursuing world-class status enjoy the largest space, followed by universities developing world-class disciplines, regular undergraduate universities, newly-established universities and independent colleges.

2.6 *Online Teaching and Learning*

In recent years, Chinese HEIs have strengthened online teaching platforms and vigorously developed online teaching resources. In 2019 and 2020, China held China MOOC and Global MOOC Conferences, and published the *Beijing Declaration* (Wu, 2020). Online teaching and learning also plays an important role in undergraduate education development and reform. During the COVID-19 pandemic, online teaching has expanded tremendously and reached a historic high in terms of the number of teachers, students, and courses. A national survey on teaching in HEIs (Fan et al., 2021) shows, online teaching and learning was offered in a large scale at undergraduate colleges and universities nationwide, with 1.08 million teachers offering 1.1 million courses, totaling 17.19 million courses, and a total of 3.5 billion course registration by students. The online course offering rate at Chinese HEIs was 91%; 80% of teachers acknowledge the importance of online teaching; and students' satisfaction on online teaching reached 85%. Online teaching and learning has provided opportunities for students' learning and overcome challenges and disruptions caused by the pandemic (*ibid*). In the post-COVID era, a hybrid model integrating both online and in-person teaching continues to develop, and significant changes are taking place in terms of curriculum design, teaching and learning styles, roles of professors and students, and classroom management (*ibid*).

2.7 *Public and Private Funding Resources*

In terms of funding resources, community input has become an increasingly important force in higher education governance and management. A structure of "government funding as the main financial resource with support from various societal forces" has been formed (Fan et al., 2021). Implemented in 2012 and further amended in 2016, *Private Education Promotion Law of the People's Republic of China* has "supported the development of private education" and "reassure the autonomy of private-run schools". These policies have strongly inspired the development of private education. Figure 6 shows that the proportion of private HEIs in China, which mainly focus on training a technically skilled workforce, has increased from 3.9% in 2005 to 33.4% in 2020 with the number of private HEIs also increasing each year. There are 416 private regular undergraduate institutions in 2020, accounting for 30% of the overall regular HEIs nationwide (*ibid*) (Fig. 7).

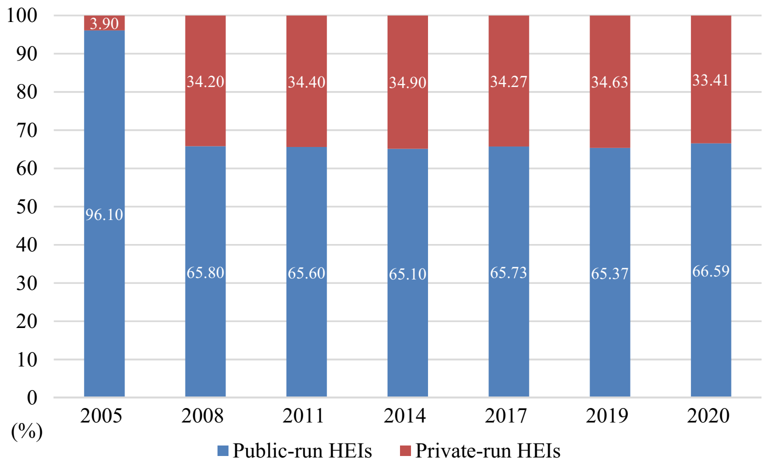

Fig. 6 The percentages of public- and private-run HEIs in China (2005–2020) (%). *Source* Compiled from National Bureau of Statistics (2005–2020)

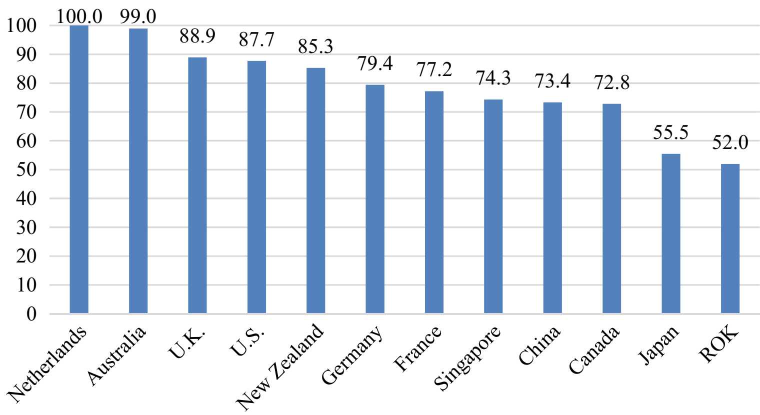

Fig. 7 Overall performance of undergraduate education

3 Excellence Indicators

3.1 Design

The quality of undergraduate education not only determines the quality of postgraduate (master's and doctoral) programs, but also has a direct impact on a society's science and technology advancement and its productivity, as well as on its higher education funding and drive for development (Weng, 1999). This section analyzes and evaluates undergraduate education in China through a global comparison.

3.1.1 Indicators to Evaluate Undergraduate Education

Various research has attempted to evaluate undergraduate education quality in the past few decades. Chickering and Gamson (1987) explored "seven principles for good practices in undergraduate education". Ewell and Jones (1996) based on their empirical studies and designed "indicators of good practice", covering the four domains of institutional requirements, instructional "good practice", student behavior, and self-reported cognitive development. Since 2019, China Association of Higher Education (CAHE) has published the first national "Teaching Development Index" to measure teaching quality at regular HEIs in China. This index focuses on six dimensions, including teaching forces, teaching reform projects, teaching material reform, research papers on teaching, teaching achievement awards and teacher training centers, and one special dimension of teaching competition, which is also called a "6 + 1" model (CAHE, 2019). In recent years, Chinese scholars have been actively exploring an evaluation system to measure comprehensive capacity of higher education in China. In 2014, Zhang et al. (2014) constructed an evaluation system to measure regional higher education capacity in China from seven dimensions, including regional higher education scale, faculty development, internationalization, informatization and digitalization, social services, funding from local government, and funding from private resources. This evaluation system is applied to evaluate higher education capacity in each province with data from 2010. Relevant analysis shows that higher education evaluation usually adopts a grand framework of "scale, structure, quality, and efficacy", a process framework of "input, process, and output", a function framework of "workforce development, research, social services, and culture heritage", and a supply–demand framework of "supply, demand, engagement, performances, and productivity" (Huang & Sun, 2018). However, there is little country-specific studies on undergraduate education evaluation and comparison.

Thus, this chapter intends to construct an evaluation system to measure undergraduate education in three dimensions of "scale, resources and performance". The selection of indicators follows the following principles: to adopt objective statistical data; to select indicators from public statistic databases; to select core indicators; to examine the development of undergraduate education within the past five years. In addition, some specific indicators are employed, including the average growth rates of undergraduate student enrollment and graduates with a bachelor's or equivalent degree within the past five years (see Table 2).

3.1.2 Sampling

To analyze undergraduate education in China in a global context, this chapter selects 11 countries with relatively developed undergraduate education systems, including the U.S., the U.K., Germany, France, the Netherlands, Japan, the Republic of Korea (ROK), Australia, Canada, Singapore, and New Zealand, mainly involving countries in North America, Europe, Asia, and Oceania.

Table 2 Excellence indicators of undergraduate education

Dimensions	Indicators	Data sources
Scale	1. Undergraduate enrollment 2. Graduates with a bachelor's or equivalent degree	OECD, and national statistic agencies
Resources	3. Percentage of world-class universities among quality undergraduate institutions 4. Percentage of quality undergraduate institutions per one million population	ARWU, QS
Performance	5. Percentage of labor force at 25–64 year-olds with a bachelor's or equivalent degree 6. Average annual growth rate of undergraduate enrollment 7. Average annual growth rate of graduates with a bachelor's or equivalent degree 8. Percentage of international students	OECD, and national statistic agencies

Source Compiled from ARWU, OECD, QS, and several national statistic agencies

3.1.3 Data Collection and Analysis

This study collects data from the OECD websites. If the data of individual countries are missing from OECD, it is then collected from its national statistics agency and sometimes from the official websites of Academic Ranking of World Universities (ARWU) and QS. Most of the data collected here are for 2019, with some data for 2020.

When analyzing, data for the eight indicators are firstly standardized; then the scores of each indicator for each sample country are added for the initial value of its undergraduate education index; and last, the initial values are further standardized for comparison.

3.2 Definitions

3.2.1 Enrollment by Age—Overall Undergraduate Enrollment

The data on overall undergraduate enrollment are mainly collected from the OECD website. It adopts the OECD definition as "number of students enrolled in bachelor's or equivalent level programs". The data for China are from the MOE, and that of Singapore is from the website of Singapore Department of Statistics.

3.2.2 Graduates at Bachelor's or Equivalent Level

The data on graduates at bachelor's or equivalent level are mostly from the OECD website. It adopts the OECD definition as the number of people who graduated from an education program at bachelor's or equivalent level. The data for China are from the MOE, and that of Singapore is from the website of Singapore Department of Statistics.

3.2.3 Percentage of World-Class Universities Among Quality Undergraduate Institutions

This indicator measures performance of quality undergraduate education programs in the sample countries. Based on the existing literature on world-class universities, this study defines those institutions entering the top 200 in ARWU and QS Rankings as "world-class universities", and those institutions entering the top 1000 in ARWU and top 1300 in QS Ranking as "quality undergraduate institutions". These data are collected from ARWU and QS websites, using the latest year's results available.

3.2.4 Percentage of Quality Undergraduate Institutions Per One Million Population

This indicator measures the relationship between population and quality undergraduate education. The data on the sample countries' population are from the OECD website and the data on quality undergraduate education are collected same way as the previous indicator.

3.2.5 Percentage of 25–64 Year-Olds with Bachelor's or Equivalent Degrees

Data for this indicator mainly comes from the OECD statistics. This indicator presents internationally comparable data regarding the labor force status and the educational attainment level by the National Educational Attainment Categories (NEAC) as reported by the Labor Force Survey (LFS) and published in OECD's *Education at a Glance 2021*. For trend data, the *Education at a Glance* database includes data from 1981 to 2020 (or years with available data).

Nevertheless, some data is missing, for example Singapore; and there are also inconsistencies in the year of data, for example, the latest data for Japan is of 2019, while other countries 2020 data.

It should be noted that, as the data of China in this indicator were lastly updated in 2010, it is relatively out of date and less comparable with the data of the other countries. Therefore, we need to project the data based on the information and data collected. According to *China Statistical Yearbook 2020* published by National

Bureau of Statistics of China (2021), a survey of the national population over six years old found that 6.27% of the population hold a bachelor's degree. The number of the population over six years old is more than the number of labor force, thus the number of 6.27% cannot be used directly. OECD's statistics show that, in 2019, China has a 1.35 billion population over five years old and about 0.84 billion labor force aged 25–64 (OECD, 2021), which can estimate the percentage of labor force in China is about 62.5%. It can be inferred that the percentage of labor force with a bachelor's or equivalent degree is around 10% in 2019.

3.2.6 Average Annual Growth Rate of Undergraduate Enrollment

This indicator measures the average annual growth rate of undergraduate enrollment for each country over the period of 2014 ~ 2019. Data for the sample countries are mainly collected from the OECD, while data for China are obtained from MOE and Singapore from its Department of Statistics.

3.2.7 Average Annual Growth Rate of Graduates with a Bachelor's or Equivalent Degree

This indicator measures the average annual growth rate of graduates with a bachelor's or equivalent degree in the period of 2014–2019. Data for the sample countries are mainly collected from the OECD, while data for China are obtained from MOE and Singapore from its Department of Statistics. In addition, the 2014 data for Japan are collected from Japan's Web Archiving Project (https://warp.ndl.go.jp/), and that of France is from its National Institute for Statistics and Economic Studies. The average annual growth rate of graduates with a bachelor's or equivalent degree is calculated as.

3.2.8 Share of International Students Among All Students–Bachelor's or Equivalent Level

Data for this indicator mainly come from the OECD statistics. This indicator presents percentage of international students among overall undergraduate enrollment. It reflects to what extent a country's undergraduate education is internationalized.

3.3 Findings

The development of Chinese undergraduate education can be analyzed through the above-mentioned eight indicators and can also be reflected through a comparison with that of the other sample countries.

Table 3 Comparing Chinese undergraduate education's development with the 11 selected countries

Dimension	Indicators of undergraduate education	Ranks of China's undergraduate education over all the 12 countries
Scale	1. Undergraduate enrollment	2
	2. Graduates with a bachelor's or equivalent degree	1
Sources	3. Percentage of world-class universities among quality undergraduate institutions	10
	4. Percentage of quality undergraduate institutions per one million population	12
Performance	5. Percentage of labor force at 25–64 year-olds with a bachelor's or equivalent degree	12
	6. Average annual growth rate of undergraduate enrollment	5
	7. Average annual growth rate of graduates with a bachelor's or equivalent degree	4
	8. Percentage of international students	/

3.3.1 Performance of China's Undergraduate Education in the Eight Indicators

Quantitative analysis on the eight indicators found that China's undergraduate education ranks among the top in the two indicators of "the number of graduates with a bachelor's or equivalent degree" and "overall undergraduate enrollment" and ranks at an intermediate level in terms of "average annual growth rate of undergraduate enrollment" and "average annual growth rate of graduates with a bachelor's or equivalent degree". However, its performance on "percentage of world-class universities among quality undergraduate institutions", "percentage of quality undergraduate institutions per one million population" and "percentage of labor force at 25–64 year-olds with a bachelor's or equivalent degree" is not satisfactory. (see Table 3).

3.3.2 Overall Performance of China's Undergraduate Education

The comparative analysis shows that the Netherlands' undergraduate education has the best overall performance, mainly because of its leading performance in terms of "percentage of world-class universities among quality undergraduate institutions" as well as its performance in terms of "percentage of labor force at 25–64 year-olds with a bachelor's or equivalent degree", "percentage of international students", "average annual growth rate of undergraduate enrollment". China's overall performance in undergraduate education is relatively strong among Asian countries, mainly because its performance on "overall undergraduate enrollment", "average annual growth rate of undergraduate enrollment" and "average annual growth rate of graduates with a bachelor's or equivalent degree" are not only higher than most of the Asian countries, but also higher than Canada.

3.4 Discussion

Since the socio-economic reform in the 1980s, the development of undergraduate education in China has made remarkable achievements with the government's strong support and promotion especially in the past two decades. In recent years, the undergraduate education sector in China continues to emphasizes on its quality transformation with the policy goal of "building world-class undergraduate education". Focuses have been laid on student-centered teaching and learning, actively implements teaching and curriculum reform and aspires to promote world-class undergraduate programs; meanwhile it also attaches great importance to delivery of Chinese traditional culture and traditions and is committed to providing quality education with Chinese characteristics.

The comparative analysis in this chapter suggests that the most obvious problem of China's undergraduate education is its lack of world-class universities. It is true that China has made tremendous progress in the past two decades to develop academic excellence through the government funded excellence initiatives, such as Projects 211 and 985 as well as the Double World-Class Project, however, compared with the other sample countries, China still has lower "percentage of world-class universities among quality undergraduate institutions" and efforts to build world-class universities are still to be strengthened. While the indicators need further elaboration due to limitations related to data availability, these findings are of practical significance for informing the future development of China's undergraduate education.

4 Best Practices

4.1 Advocating Independent, Cooperative and Inquiry-Based Learning Styles to Cultivate Top-Notch Undergraduate Talent

4.1.1 Building an Interdisciplinary Environment and Inspiring Innovative Thinking in Students

In order to enhance students' awareness and vision of interdisciplinarity, the University of Science and Technology of China (USTC) has been exploring new interdisciplinary models for talent development. USTC launched the Interdisciplinary Excellence Training Program for the Gifted Young Class in 2016. This program requires 40 additional credits of courses in a second major in addition to the primary major, and the dissertation topic should be in a cross-disciplinary direction related to both majors, aiming to cultivate leading talents in various industries with a broader knowledge background and strong capabilities to respond to the rapid development of future society (USTC, 2022). An undergraduate research program focused on interdisciplinary innovation is also an important approach to develop world-class undergraduate education at the University of California, Irvine (UC Irvine). The Multidisciplinary Design Program at UC Irvine was launched in 2011 with a team of five undergraduate students from different disciplines and two faculty members from different colleges to focus on specific social issues and encourage students to develop new topics and perspectives in their research projects (Wang, 2020).

4.1.2 Developing Research Training Based on a Cognitive Apprenticeship Method to Enhance Problem-Solving Skills in a Community of Practice

In order to overcome the weakness of the "assembly-line like" traditional training method, Shanghai Jiao Tong University (SJTU) adopts the cognitive apprenticeship training method to enhance students' learning motivation and their skills and abilities to solve complex problems in the process of learning, practice, relearning, and re-practice. Undergraduate students participate in research in three steps. First, the advisor creates a real-life problem and demonstrates the basic logics and strategies to solve such problem, while students as "novices" observe, imitate, and learn the methods and approaches the advisor adopts. Second, the advisor builds a "scaffolding" to provide students with research ideas and framework and students then practice and experience the whole research procedures under the advisor's guidance, including searching for research literature, implementing experiments and analyzing data. Finally, the advisor extends the research questions and contexts, removes the "scaffolding", and assigns more complex research tasks (Shen et al., 2021).

4.1.3 Developing Academic Communities and Constructing Academic Identities

By bringing together the world's top scientists (including Nobel Prize and Turing Award winners) and a group of students who aspire to reach the top of the academic ladder, Zhiyuan College at SJTU nurtures "future masters" with "masters", and students' academic identities are gradually internalized throughout the process. The entire college, each class, each discussion group, each project group, each classroom and even each dormitory at the college can form a learning community. Through guiding scientific research, classroom discussions, and after-class communications, advisors not only teach students knowledge and methods, but also use their own words and deeds to influence students' emotions, attitudes, and values. Impacted by top scientists' research attitudes, students are more willing to follow their example to engage in academic research (*ibid*).

4.2 *Improving Multi-level Teaching Evaluation Systems to Ensure the Quality of Undergraduate Education*

4.2.1 Strengthening Descriptive Evaluation to Enhance Academics' Teaching Skills

A simple score and grade evaluation has the disadvantages of weakening the integrity and complexity of classroom teaching and restricting teachers' subjectivity and professional development, while descriptive teaching evaluation focuses on the cognitive, emotional, and interpersonal interactions of teachers and students in classroom teaching, understands and interprets their behaviors, and provides non-quantitative evaluation results and recommendations (Yan, 2012). In order to help teachers conduct self-analysis and self-improvement, Nanjing University (NJU) further highlights ethics and morals as well as teaching performance in its peer review evaluation, and adds a "descriptive evaluation" section (NJU, 2021).

4.2.2 Building Diversified Evaluation Mechanisms to Guarantee Comprehensive Classroom Teaching Quality

To improve the objectivity, accuracy and reliability of classroom teaching evaluation, Wuhan University (WHU) integrates student evaluation with third-party evaluation. The result of student evaluation is an important reference for teachers' teaching assessment, excellent undergraduate teaching performance award and various merit awards, and also an important reference for faculty's professional appointment and promotion. In response to the student evaluation results, the university has provided individual feedback to the corresponding schools/departments and requested the schools/departments to carry out relevant inspection and improvement plans (WHU, 2019). A third-party evaluation was also introduced to invite experts from peer universities to assess teaching in the universities' general courses. Experts from Wuhan University Institute of Education Science are also invited to review teaching quality of general courses, such as Advanced Mathematics and English (*ibid*).

4.2.3 Strengthening Qualification Requirements for Undergraduate Teaching to Improve New Faculty's Teaching Skills

To ensure new faculty's teaching skills, WHU has raised its qualification requirements for teaching undergraduate courses and new faculty members need to pass "four hurdles" before they can take the podium. The first hurdle is to attend the intensive teacher training organized by the Human Resource Department. Second, they need to participate in various teaching training programs organized by the Center for Teaching and Learning Development, including lectures on teaching, observation, teaching workshops and seminars. For the third hurdle, new faculty members serve as a teaching assistant for an undergraduate course, assisting the main instructor by completing course tutoring, answering questions, grading assignments, and guiding experiments. The last requirement is a teaching assessment; the new faculty member teaches part of the course as a second instructor with supervision from the main instructor. The Center for Teaching and Learning Development oversees the assessment processes and basis their decision upon on expert reviews, student evaluations, and faculty recommendations. Those who do not pass the assessment will repeat this final step. After passing all the four hurdles, the new faculty member will be qualified to teach undergraduate courses independently at WHU.

4.3 Integrating Practice into Teaching and Learning to Enhance Undergraduate Students' Innovation and Entrepreneurial Skills

4.3.1 Advocating Experiential Learning to Improve Students' Practical Skills

Experiential learning focuses on allowing students, based on their practical experience, to solve real-life problems through the process of operation, illustration and application, and, therefore, actively construct knowledge and acquire learning methods and skills (Chen & Huang, 2008). The X-Lab at Tsinghua University intends to introduce project-based experiential learning to develop students' practical skills. This is a teaching method that breaks the traditional concept of teacher imparting knowledge and students learning knowledge (Tsinghua University, 2018). Ivy League schools in the U.S. also emphasize students taking on an active role in teaching and learning. For example, the Presidential Scholar Program at Dartmouth College provides undergraduate students with "one-on-one" mentoring by professors, exposing them to the frontiers of the disciplines and gradually developing their problem awareness and problem-solving skills (Ye et al., 2020).

4.3.2 Promoting Interdisciplinary Integration to Enhance Students' Creativity

Relying on Tsinghua University's School of Economics and Management, the X-Lab is jointly built by several faculty on campus, creating a space for interdisciplinary teamwork and exchange of student innovation and entrepreneurship. The platform promotes cross-collaboration among 16 faculties including the School of Economics and Management and the School of Mechanical Engineering (Tsinghua University, 2020). Students are guided to combine art and science, engineering and business, technology and production, and learn management thinking, innovation and entrepreneurship, so as to establish a complex cognitive system of “technology + management” (*ibid*).

4.3.3 Establishing a Collaborative Learning Mechanism Between Universities and Industry to Develop Students’ Skills to Solve Complex Real-World Problems

In order to make students’ entrepreneurial projects more objective and realistic, Tsinghua University cooperates with enterprises to explore new education models. Tsinghua University’s X-Lab collaborates with enterprises to explore new courses on innovation and entrepreneurship, such as working with Facebook to design and offer a new course titled “Innovation and Entrepreneurship: Silicon Valley Insights” (*ibid*). At the same time, X-Lab also invites outstanding entrepreneurs to guide students’ entrepreneurial projects, being the first university in China to introduce the “Entrepreneur-in-Residence” and “Angel-in-Residence” programs, which participate in practice education, provide advice and suggestions, and introduce relevant resources to students. The program is designed to turn creative ideas and technologies into products and services demanded from the society (Tsinghua University, 2020). The emphasis on undergraduate entrepreneurship programs is also a hallmark of the Nanyang Technological University. Nanyang Technological University’s Entrepreneurship Minor Program for undergraduates, is taught by business leaders, entrepreneurs, intellectual property lawyers and professional academics, and aims to equip students with basic entrepreneurial skills, business acumen, and stamina (Shi, 2021).

5 Inspiring Stories

5.1 Yao Chichi: Holding Primary Responsibilities of Teaching and Learning

Yao Chichih, the first recipient of the Distinguished Master Teachers[2] award by the MOE, is a world-renowned scientist and a front-line teacher. He teaches foundational undergraduate courses, and his “Yao Class” model, that is an Experimental Class of Computer Science, is regarded as “the best undergraduate education program” in the world. Yao is considered as a leader in innovative talent training (MOE, 2019b).

[2] The Distinguished Master Teachers award mainly recognizes faculties who have made outstanding achievements in talent cultivation, specially nurturing national strategic and scarce talents, have global outstanding teaching influence and are devoted to teaching in the front line.

5.1.1 Committed to Training the Best Undergraduate Students in the World

Undergraduate education is the key stage for building students' basic theoretical knowledge, and Yao attaches great importance to undergraduate teaching in his work. He taught "Theoretical Computer Science", a basic course for first-year students, which influenced the life path of many students. One of the students benefitted from this course is Wang Jun-Xing. In the class, Yao inspired the students with a computer system problem. When Wang proposed a solution to a problem that had plagued the academic community for 30 years, Yao suggested that he write down the idea (Tsinghua University, 2015a). After several months, Yao assisted Wang submit his article to journals. This was the very first article in English that Wang wrote, which was published in his sophomore year (*ibid*). Yao motivates students to take initiative and inspire their thinking. When inspiration strikes, he further encourages students to enjoy and experience the joy of research.

A student survey on Yao's "Computational Applied Mathematics" class showed that 100% of the students were satisfied with the course; 100% of the students agreed that the class left a deep impression on them (Yang, 2019). Behind these double 100% figures is Yao's tireless dedication. Yao's teaching assistant, Li Chenxing, once said, "There is no textbook assigned for this course, and there are no related exercises books on the market; the content of the course is completely designed by Yao himself, and all the homework and exam questions are also provided by Yao himself, and the questions are changed frequently (*ibid*)."

5.1.2 Yao's Classes for Cultivating Special Talents

Yao established an "Experimental Class of Computer Science", commonly known as "Yao Class" at Tsinghua, with the goal to train elite computer science students who are comparable to, and even more exceptional than the world's leading universities.

Courses delivered in Yao Class are very challenging. Students sometimes may need a whole day to complete a single assignment and sometimes may not even find ideal answers. Haoqiang Fan, an undergraduate student of the 2013 class once pointed out that they were only freshmen or sophomore year students but were assumed to have mastered all the basics, and these courses focused on in-depth analysis and framework (Tsinghua University, 2015a). Many students were quite reluctant at the beginning but gradually realized that they actually managed it and mastered the class. Rediscovering themselves, students were surprised and motivated, greatly stimulating their potential, and many of them even took the initiative to contact their advisors to find a topic and conduct research on it (*ibid*). Yao said, "I hope, instead of pressure, the environment at Tsinghua will allow people to experience and feel the challenges and breakthroughs in the learning and research process, as well as the happiness that comes from it" (*ibid*).

Yao believes that an international atmosphere is required if undergraduate education at Chinese universities is to compare with that of world-class universities. Yao led his colleagues to redesign the undergraduate computer science curriculum, optimizing and reorganizing the coursework to comprehensively cover the frontier areas of computer science research and highlight its interdisciplinary nature. With Yao's invitation, top scholars such as Turing Award winners have walked into Tsinghua's classrooms to bring students an international experience. Yao Class student Shi Tianlin, who was an exchange student at MIT in 2013, was surprised to find that the teaching and learning methods he experienced in class could be "seamlessly integrated" with the world's top universities (*ibid*).

5.2 *Lin Yifu: Joy of Working with Elite Students*

As a passionate teacher, Lin Yifu has contributed to enhancing elite students' innovation skills in the field of economic theories and has been teaching undergraduate classes for more than 20 years and is committed to teaching and nurturing students (Peking University, 2021).

5.2.1 Establishing Lin Class to Focus on Nurturing Students

Lin founded the "Experimental Class of New Structural Economics", commonly known as "Lin Class". Lin led his team in making education plans and designing the curriculum, to ensure its teaching content focuses on foundation knowledge in the field of economics and cultivates students' innovation skills and skills to address challenges of the changing world (Peking University, 2020). The core courses featured specially-designed content and a personalized teaching model with small classes, seminars, and one-on-one Q&A sessions (*ibid*). Students in the experimental class are able to communicate and interact directly with Lin and are greatly inspired and more likely to prevail (Peking University, 2021).

Students in Lin Class enjoy the opportunity to have lunch with Lin once every month. During the luncheons, Lin listens and offers suggestions to students' questions and comments about their academic life, and provides further detailed feedback in writing afterwards (Peking University, 2020). In addition to his classroom instruction and lunches with students, Lin often has long talks with his students, patiently responds to students' questions, advising and revising students' assignments word by word. His students have also gathered all their discussion and exchanges into a book, named *The Gardener's Book* (*Yuan Ding Ji*) (*ibid*). Lin's teaching methods demonstrate that students learn better in a relaxing and cordial environment.

5.2.2 Personality Charm

Students all agree that Lin and his personality are "as high as a mountain". Though it is hard to reach, students are deeply influenced by Lin's personality and charisma and always look up to him as a role model (Chen, 2017). Lin often tells students that, as intellectuals and knowledge workers in China, students should take responsibility for the progress and advancement of society (Sun, 2017b). One student, Cui Jingyuan, once wrote that Lin's life experience shows that "every era needs a group of ascetics, and doing research is a kind of practice, practicing for the people, the motherland, and the world, and eventually I also chose this path". Lin impacts his students with his charisma and profound learning in every aspect.

Lin has always insisted on unity of knowing as doing. On the night before the Master Teaching Award, Lin was still on campus teaching a class to undergraduate students. Only after the class was over, he ran to the airport and take a late flight. When asked why he did not consider changing the course time, Lin replied, "The Master Teaching Award is an encouragement to me, and if I changed my class time in order to get the award, I would not be qualified to get the award" (Bund Education, 2021). An increasing number of students are influenced by Lin and his personality and follow the belief "knowing as doing".

5.3 Wen Yumei: Nurturing Students with Heart

Wen Yumei considers students as her own kids and has devoted herself to teaching for more than 60 years. She has edited many classical teaching materials, dedicated herself to training medical talents, developed an online general education course "Humanities and Medical Sciences, and composed a symphony of medicine and humanities.

5.3.1 Serving Children for Life

Wen believes in quality cultivation and teaching with heart. Her teaching philosophy is that teachers are responsible for "lighting the fire in students' hearts" and facilitating students to grow (Feng et al., 2011). She is good at exploring different students' strengths and weaknesses and teaching them accordingly. She creates different learning conditions and guides them in their quest for knowledge. To expand students' horizons, she sponsors them to attend and present at international student conferences. To improve students' English reading and writing skills, she organizes English study clubs and personally leads them to read books in foreign languages (Shanghai Education, 2017).

Wen always makes time for her students and inspires students with her personality and charisma. She encourages students to persevere in their studies and stay curious. In her classes, students not only listen to her exciting lectures and enjoy acquiring profound knowledge from Wen, but also are influenced by the ethics and moral values hidden in the curriculum, because Wen believes and sees classroom as a place to create a positive culture among students. In the Introduction to Medical Microbiology class, she tells a story of germ warfare, the story of Bai Quyen, etc., so that students can deeply appreciate the patriotism, mission, and national pride (*ibid*). She does all this to encourage students to combine their dreams with the "Chinese Dream" and actively participate in the great cause of national development.

5.3.2 Pioneering Innovative Teaching Methods

Wen has been boldly trying to reform in her teaching practice. She perseveres her teaching to bring the latest cutting-edge knowledge in the field from unique perspectives to students. The course she offers has been one of the most enrolled courses in the university. In order to strengthen foundational medicine courses, she actively engages in teaching reform and was the first to teach the "Introduction to Basic Medicine" course (Zhu et al., 2021). In order to cultivate students' skills to develop and raise questions, she sets up a prize for the best question and awards the student who asks the best question a signed book, to fully motivate students and improve their understanding and learning.

Wen often says to the teachers in her teaching team, "When teachers stand on the podium to face the eyes of students seeking knowledge, we have to keep in mind our responsibility not to mislead them" (Shanghai Education, 2017). Even if it is a class that she teachers every year, she will recreate the handouts and slides to bring the latest knowledge to everyone. Sometimes for a slide, she would take careful attention to revise it repeatedly. Many students have decided to join medical microbiology research and education after taking Wen's class.

6 Latest Research

6.1 An Overview of Research on Undergraduate Education in China

With the rapid development of undergraduate education in China, increasing research on relevant topics have emerged in academia. Through literature search, this chapter adopts a quantitative analysis to provide an overview of undergraduate education research in China, reviews research fronts, and explores research originality in the past ten years.

To ensure reliability and validity, this study selects core journals in the field of higher education indexed in the databases of "Chinese Social Sciences Citation Index (CSSCI)" (2021–2022) and "the Chinese Core Journal List" (2021 edition) as sampling criteria. Through an advanced search in the higher education journals indexed in these two databases, this study retrieves 2447 journal papers focusing on undergraduate education and published from January 1, 2012 to December 31, 2021.

This study intends to analyze literature related to "undergraduate education" through a knowledge mapping analysis using CiteSpace, and to explore the research

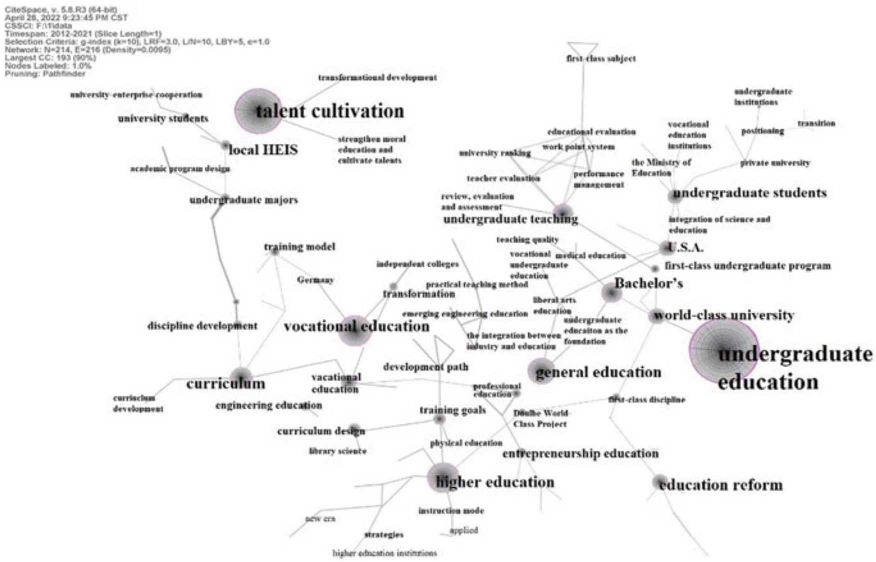

Fig. 8 Clustering view of research on undergraduate education (2012–2021). *Source* Compiled from search results from CNKI

development and fronts in the field of undergraduate education. After the converted data are imported, the time span from 2012 to 2021 is selected. The analysis process is configured through a few parameters[3] to achieve clear visualization results. The visualized knowledge map of keywords is shown in Fig. 8.

In Fig. 8, N = 214 indicates 214 keywords nodes, and E = 216 indicates 216 links between these keyword nodes. The circles in the figure stand for keyword nodes. The larger the circle, the more frequently the keyword occurred. Among them, "undergraduate education" has the largest node, followed by "talent cultivation", "tertiary vocational education", "general education", "higher education", "bachelor's", "teaching reform", "curriculum", and "undergraduate teaching". Keywords are often just a few words and take up relatively little space in the paper, but they are the essence of the paper. Literature can be retrieved through keyword searches, meanwhile keywords can help readers understand the scope and contents of an article. Research themes and focus can be found through analyzing high-frequency keywords (Jiang et al., 2008).

This chapter analyzes the retrieved journal papers from multiple perspectives by using the network summary table function in CiteSpace. The top 15 keywords are identified in terms of frequency, which reflect the research focus on undergraduate education in China (see Table 4). Although the keyword "undergraduate education" has the highest frequency, it does not reflect the detailed research themes and topics in the field of "undergraduate education". The same is true for the keywords "higher

[3] *Note* The parameter selection panel of the software sets g-index (k = 10).

Table 4 Top 15 frequently used keywords

Keyword	Times used	Keyword	Times used
Talent cultivation	135	entrepreneurship education	27
Tertiary vocational education	103	specialized education training model	24 21
General education	60	training goals	21
Education reform	46	curriculum design	20
Curriculum	44	local HEIs	20
Undergraduate teaching U.S	43 33	world-class undergraduate program	18
World-class university	31		

Source Compiled from search results from CNKI

education", "undergraduate", and "undergraduate students". Therefore, these words are not included in the top 15 keywords. The top three ranked keywords are "talent training", "tertiary vocational education", and "general education".

6.2 Research Focus

According to the frequency and the analysis of related literature, the topics of undergraduate education research that are mostly researched on can be identified, including "talent cultivation", "tertiary vocational education", "general education", etc.

6.2.1 Research on Undergraduate Talent Cultivation

Talent cultivation is one of the essential functions of universities, and undergraduate education is the root and foundation of higher education (Chen, 2018b). Through reviewing existing literature, scholars have focused on exploring modes of undergraduate talent cultivation in terms of goals, plans, and approaches.

Maoyuan Pan (2005a), a renowned educator and academic master of higher education research, pointed out that, since higher education is diversified and HEIs are of diversified types, goals for talent cultivation must be diversified. For example, undergraduate education at practical and profession-oriented universities should set up their goals as serving local socio-economic development, meeting skill demands of industries and enterprises, ensuring curriculum content connecting and relevant to real world experience, and enhancing students' employability (Wu & Huang, 2014), while research universities should focus on training elite undergraduate students with both discipline-specific knowledge and comprehensive abilities (Li, 2012). In terms of student training plans, practical and profession-oriented universities should ensure their programs are closely connected and relevant to local workforce development needs and specialized industries (Xue & Wang, 2016); while research universities should stress on education and training of top innovative talents, develop specialized disciplines to cultivate students' professional knowledge, expertise, innovative awareness and creativity and to design interdisciplinary courses to train multidisciplinary and comprehensive skill force (Li, 2022).

HEIs with different goals adopt different training approaches towards teaching and learning. University-industry research collaboration and university-enterprise cooperation are essential to train technical talent (Wu & Huang, 2014); while research universities should develop disciplines to support subjects and transform disciplinary advantages to that of talent training (Lu, 2018).

6.2.2 Research on Tertiary Vocational Education

As early as the beginning of the twenty-first century, some scholars intended to categorize tertiary vocational education (Pan, 2005b; Shi & Xu, 2003). With the introduction of a series of policies on vocational education, increasing attention has been placed on tertiary vocational education. Listed in the State Council's, 2019 *National Implementation Plan for Vocational Education Reform* (2019), vocational education was piloted at the undergraduate level as a major reform, which set off a research boom on this topic. In terms of its nature, Wang and Qi (2022) believe that tertiary vocational education is both practice-oriented and technical in nature. The goal of tertiary vocational education is to train technical talents at undergraduate level (Lu, 2019). In terms of training approaches, through analysis on the development, reform models and approaches of vocational education in foreign countries, Liao (2020) explores the reform paths and direction to develop tertiary vocational education from the perspectives of its nature, features, and goals, so as to provide theoretical support to improve the vocational education sector in China.

6.2.3 Research on General Education

Cai Yuanpei, Pan Guangdan, Zhu Guangqian and other famous educators have introduced general education into Chinese universities and put it into practice (Yang, 2000). Research on general education focuses on exploration at the theoretical level and promotion at the practical level. At the theoretical level, Chen (2006) critically reviewed its definition and its differences from professional learning, liberal education, liberal arts education, quality education, specialized education, as well as general elective and commonly required courses; Li and Wang (1999) analyzed the definition and nature of general education; and Liu (2012) proposed that general education carries the basic goal of university education, that is to develop students as a whole person. At the practical level, scholars investigate the opportunities and challenges to develop general education. Su and Li (2018) analyzed the challenges and implications to reform general education at Tsinghua University and discuss the logical relationship between general education curriculum and its goals in terms of competence; Yu (2016) adopted a case study of China University of Political Science and Law to examine the status quo of general education in the Chinese higher education context and proposes recommendations to further promote such programs.

6.3 Research Originality

Academics play the main role in developing scientific research in China. Research results in the field of education are mainly published in the forms of papers and books (Gong, 2009). A review of the existing research literature on undergraduate education in China in recent years reveals that academics' original research not only enriches related theories but also makes a positive impact on policymaking and practices of undergraduate education in China.

At the theoretical level, Pan Maoyuan has been greatly contributing to rich theoretical discussion of the development of undergraduate education in China, including theories on the essence of higher education, the law of internal and external relations in education, Chinese higher education massification, basic function of HEIs, private higher education, curriculum and instruction in higher education, developmental stages of disciplines in higher education, etc. (Liu & Tang, 2020). Gu Mingyuan also provides rich and forward-looking educational thoughts. The importance of undergraduate education in university education has become a heated topic in recent years; Gu first published the paper titled "Undergraduate education is the foundation of higher education" back in 1990. Lately, he also proposes "the university reform should emphasize on undergraduate teaching, and the best teachers should return to the podium and teach students" (Zhang & Li, 2018). Bie's theoretical research is based on practices and provides theoretical support to undergraduate teaching reform (Zhang, 2011). In the article "Rebuilding undergraduate teaching", he surveys the main problems and challenges and then argues that the reform of undergraduate teaching should start with transforming the concepts of undergraduate education (*ibid*).

Some academics conduct innovative and leading research on educational practices. Liu Xian-Jun of Huazhong University of Science and Technology opens up a new area of institutional research in Chinese higher education, shifting structural research at the theoretical level towards problem-probing and -solving in practices, and conducting in-depth systemic research on higher education governance and management (Zhou, 2017). In relation to research on faculty, recent research focuses on student-centered teaching methodologies and approaches. For example, Zhou and Zhou (2002) employ surveys and classroom observations (recording) to investigate faculty's discourse in terms of discourse quantity, ways to ask questions, interactions, and feedback. From the perspective of student experience, Luo et al.

(2009) use NSSE-China survey tool to compare the performance of Tsinghua University's undergraduate education with its peer institutions in the U.S., for five comparable indicators, educational stages and student attainment. The result shows that Tsinghua's undergraduate teaching quality is largely comparable to its world-class peers in the U.S.

7 Governmental Policies

7.1 General Policies

7.1.1 Educating and Training the Top-Notch Undergraduate Students

Chinese undergraduate education emphasized developing the best students at the beginning of the economic reform in the 1980s. At that time, the University of Science and Technology of China (USTC) established the first Class for the Gifted Young, the first pilot program to train top talented students in basic science disciplines (Ye, 2014). In 2009, in response to the "Qian Xue-Sen's question"—why do Chinese universities lack of elite talents—the government further focuses on educating and training the top talented students.

In 2009, the MOE, in partnership with the Ministry of Organization and the Ministry of Finance, launched the Pilot Program for Training Top Talented Students in Basic Sciences. The pilot program was implemented in the five disciplines of mathematics, physics, chemistry, biology and computer sciences (Tsinghua University, 2015b), which was the very beginning of the "Six Excellence and One Top-Notch" Talent Training Project 1.0.[4] The pilot program aims to establish a few national bases for training young talent via basic disciplines at top research universities, to build an institutional mechanism to train top students in HEIs, to attract elite students to engage in basic science research, to further transform these selected students into leading scientists in related disciplinary areas, and to eventually become leading scientists in the global stage (Du, 2014). Subsequently, this program was implemented in 17 ministry affiliated universities, including Peking and Tsinghua University (the State Council, 2010).

In 2018, the MOE issued *Guidelines on Accelerating the Development of High-Quality Undergraduate Education and Comprehensively Improving the Capacity of Talent Training* and decided to further implement the "Six Excellence and One

[4] "Six Excellences" refers to the Outstanding Engineer Education and Training Program, the Outstanding Doctor Education and Training Program, the Outstanding Agriculture and Forestry Talents Education and Training Program, the Outstanding Rule of Law Talents Education and Training Program, the Outstanding News Communication Talents Education and Training Program, and the Outstanding Teacher Training Program. "Top-notch" refers to the Training Program for Top-Notch Students in Basic Disciplines.

Top-Notch" Talent Training Project 2.0.[5] *Guidelines on the Implementation of the Cultivation Program for Young Talent Students in Basic Disciplines* 2.0 issued by the MOE and five other ministries expanded the disciplinary areas by adding astronomy, geography, atmospheric science, marine science, geophysics, geology, psychology, basic medicine, philosophy, economics, Chinese language and literature, history, etc. (MOE et al., 2018b). This program has made significant progress in terms of institutional structure, student selection, and training approaches. It also explores the new talent training approach of "one mentorship system with emphasis on student-centeredness, small class sizes and internationalization", to achieve "the best undergraduate students and the best undergraduate education programs" (Zhang, 2016).

This program aims to build a talent training system of excellence and develop world-class students with Chinese characteristics. The Talent Training Program 2.0, based on its original 1.0 program, has developed a series of talent training approaches, along with plans and standards that seek to enhance reform quality and effectiveness (MOE, 2018e). This new program has turned the original individual project into a series of plans (MOE, 2019c), from "single armed combat" to "collective forces". This reflects that Chinese higher education reform and development is shifting its role as a follower towards a leading role in certain fields—a "quality revolution" for Chinese higher education in the new era (MOE, 2019d).

7.1.2 Quality Assurance in the Respect of Undergraduate Teaching

China formally launched undergraduate teaching evaluation in the 1980 and 1990s. *The Provisional Regulations on Educational Evaluation of Regular Higher Education Institutions* announced in the early 1990s marked the formation of the basic framework for quality assurance of undergraduate education in China. In 2002, the MOE issued *(Trail) Plans for Undergraduate Teaching Evaluation at Regular Higher Education Institutions*, which intended to combine pass/fail, merit-based and randomized evaluations into one evaluation system to assess undergraduate teaching quality at Chinese universities. This has led to the standardization and institutionalization of quality assessment of Chinese undergraduate education (Liu & Li, 2018).

In 2011, *Guidelines on Undergraduate Teaching Evaluation at Regular Higher Education Institutions* proposed a "five-in-one" evaluation system. This system is based on HEIs' self-evaluation; takes institutional evaluation, professional accreditation and appraisal, international evaluation, and performance indicators of teaching quality as its main content; integrates multiple evaluation results from government,

[5] The "Six Excellences and One Top-Notch" plan 2.0 includes: Outstanding Engineer Education and Training Program 2.0, Outstanding Doctor Education and Training Program 2.0, Outstanding Agriculture and Forestry Talent Education and Training Program 2.0, Outstanding Teacher Training Program 2.0, Outstanding Rule of Law Talent Education and Training Program 2.0, Outstanding Journalism and Communication Talent Education and Training Program 2.0, and Top-Notch Student Training Program for Basic Disciplines 2.0.

HEIs, specialized organization and society; and is corresponding to the modern higher education system with Chinese characteristics (MOE, 2011). In 2012, the system to publish an annual evaluation report on HEIs' performance and quality was established and it requires each regular HEIs to publish its annual "Undergraduate Teaching Quality Report". This report can be seen as a self-evaluation approach, but also serves as important evidence for institutional evaluation on undergraduate teaching (MOE, 2013). Since 2017, the Higher Education Evaluation Center of the MOE developed and released the annual *National Report on the Quality of Undergraduate Education and Teaching at Regular HEIs*, which is the first theme-based report on Chinese undergraduate education quality. The four theme-based quality reports cover undergraduate education, engineering education, newly established undergraduate HEIs, and private undergraduate programs (Sun, 2017a).

7.2 Recent Policy Highlights

7.2.1 Developing World-Class Undergraduate Disciplines

The MOE started its so-called "Double Ten-Thousand" project on promoting world-class undergraduate disciplines in 2019. Its mission includes developing 10,000 world-class undergraduate disciplinary programs at both the national and provincial levels respectively (MOE, 2019e). The top three selected disciplines are business administration (674 undergraduate programs), foreign language and literature (609), and computer sciences (577); while over 400 programs are selected respectively in the design, digital information, and mechanical engineering disciplines. The "Double Ten-Thousand" Project is open to all HEIs and disciplines and is implemented in two stages: MOE will first evaluate those applied programs as "first-class at the national level, and after further evaluation and appraisal by MOE to confirm these programs' first-class status in the nation (*ibid*). To apply for the project, each program needs to meet five requirements: clear developmental goals, standardized management, effective reform, excellent teaching forces, and high-quality training (*ibid*).

7.2.2 Developing World-Class Undergraduate Curriculum

The MOE issued the *Guidelines on the Implementation of World-Class Undergraduate Curriculum*. The objectives to develop world-class undergraduate curriculum include:

- to design world-class and top quality undergraduate curriculum;
- to develop new curriculum development concepts;
- to promote reform and innovation on curriculum design;
- to implement effective and scientific evaluation;
- to provide clear guidelines and regulations on curriculum management;

- to stipulate rules on professors' teaching responsibility, enhancing course quality and raise standard on students' graduation requirement;
- to improve faculty's teaching ability and skills;
- to improve quality-oriented incentives for curriculum development; and
- to diversify teaching content and develop a multi-category curriculum system.

It aims to develop about 10, 000 world-class undergraduate courses at the national and provincial levels within three years (MOE, 2019f). World-class curriculum sets students in the center of the course programs, and its content reaches the "golden" standard to ensure the curriculum's breadth, depth and integration of learning.[6] Selected courses must be developed and improved for at least two semesters or two teaching cycles, with effective teaching and learning outcomes, as well as meet requirements in multiple aspects of teaching concepts, teaching outcomes, feasibility, responsiveness to changes in society, management and organization, evaluation, etc. (*ibid*). In November 2020, the MOE awarded 5,118 courses as the national first-class undergraduate courses, including 1,875 online courses, 728 virtual simulation and experiment courses, 1,463 in person courses, 868 courses of hybrid mode, and 184 internship and practice courses (MOE, 2019b)

7.2.3 Evaluating Undergraduate Teaching

In 2013, the MOE launched the first-round of teaching reviews and evaluation at regular HEIs in China, and the second-round reviews and evaluation began in 2021.

The first-round review and evaluation (2013–2018). The first-round teaching review and evaluation proposed five key questions: are the goals of teaching and learning are achieved, does the knowledge and skill development meet the societal needs, what teaching resources and conditions are supported, is quality assurance effective, and are employers satisfied with the graduates (Bie, 2021). As of July2018, a total of 560 Chinese HEIs have participated in the review and evaluation exercise (*ibid*).

The second-round review and evaluation (2021–2025). The second-round review and evaluation is divided into two major categories in terms of the university type (MOE, 2021b). The first group targets the evaluation exercise at those regular HEIs which aspire to become world-class universities with excellent teaching faculty and platforms for teaching and learning, educate and train top talented students, and serve the skill demand for national strategic development. It focuses on reviewing these selected universities' quality assurance capacity and their initiatives and effectiveness to transform undergraduate education and teaching. The second category of

[6] It refers to high order, innovation, and challenge. "High-order" refers to the organic integration of knowledge ability and quality, which is to cultivate students' comprehensive ability to solve complex problems and advanced thinking. "Innovation" means that the course content reflects the frontier and the times, the teaching form is advanced and interactive, and the learning results are inquiry and personalized. "Challenge" means that the course has a certain degree of difficulty, need to jump to be able to get it, teacher preparation and students have higher requirements under class.

the review and evaluation exercise targets at three different types of HEIs in terms of goals, mission, and history, that is: regular HEIs focusing on training academic talent, regular HEIs stressing on training technical talent, and local teaching universities. The first two types of HEIs have engaged in the first-round review evaluation, while local teaching universities have a relatively short history and participate in the review and evaluation exercise for the first time. The detailed content covered in the second-round review and evaluation include university goals for teaching and learning, teaching resources, training plans and approaches, students' development and experience, and teaching outcomes. The evaluation procedures cover: application submission, self-evaluation at the institutional level, peer review, feedback, improvement, and supervisory review (*ibid*).

7.2.4 Developing a Quality Culture

Studies on university quality culture are an important element of quality assurance in higher education (Dong & Sun, 2008). In recent years, undergraduate education in China has increasingly placed emphasis on creating a quality culture. *The 40 Guidelines on Higher Education Development in the New Era* issued by MOE (2018a) stipulates that HEIs should improve their self-evaluation system and internal quality assurance system, should build a self-evaluation system on undergraduate teaching and report evaluation result to public, and should promote discipline accreditation. *The Implementation Plans for Undergraduate Teaching Review and Evaluation in regular higher education institutions (2021–2025)*, officially announced in 2021, proposes to develop university quality culture of self-awareness, self-reflection, self-discipline, self-examination and self-correction, and to establish a sound quality assurance system for undergraduate teaching with Chinese characteristics and world standards (MOE, 2021c).

8 Summary

Undergraduate education is at the center of higher education around the world. With global development, undergraduate education in the world continues to move forward. After more than 40 years of reform and opening-up, undergraduate education in China has made great progress with the joint efforts of the government and universities. In recent years, China's undergraduate education is under continuous reform and endeavoring to become world-class, which has been recognized internationally. Dr. Carol Bobby, former chairman of The International Network for Quality Assurance Agencies in Higher Education, points out that the concepts of "school-oriented and student-centered", "classification evaluation and guidance" and the approaches of "data-based monitoring of quality and publishing quality reports" in the Chinese higher education are among the first and advanced internationally, and

Chinese' experience will provide excellent practical examples for quality assurance in large higher education systems (Fan, 2021).

In recent years, China's effort to develop world-class undergraduate education is of significance in terms of its talent cultivation. Developing world-class undergraduate education is a holistic, comprehensive, and complex systematic project. Its quality assurance mechanism helps ensure that China realizes and meets their goals of becoming world-class and achieving and sustain its quality excellence (Lin, 2019). It is believed that, with the effort of the government, HEIs, faculty, and students, undergraduate education in China will progress by leaps and bounds in the near future.

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Chapter 6
Graduate Education in China

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Abstract Globally, graduate education has been an integral part of national strategic planning, drawing heavy investment, favorable policy, and intense financial support from both the national and state government and active support from social organizations. In China, since the restoration of graduate education in 1978, Chinese graduate education has gone through arduous explorations and continual improvement. This chapter aims to provide an overall understanding of Chinese graduate education by reviewing its brief history, its development in quantity and quality as compared to other existing graduate education systems over the past decade, and the evolution of national policies and best practices concerning graduate education.

Keywords Graduate education · Comprehensive reformation · Quality assurance system · Self-auditing · Periodic evaluation

1 Introduction

The development of graduate-level (including both doctoral and master level) talents is commonly regarded as the pinnacle of the educational spectrum. Sustainable development and continual improvement of graduate education for a nation greatly contributes to the cultivation of highly skilled researchers and workforce, which in turn leads to flourishing of scientific discoveries, technological innovations, and the national economy at large. Therefore, establishing a strong graduate educational system became a strategic part of national educational policies.

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Research studies over the past four decades on global graduate education systems have indicated the competitive edge of graduate education of the U.S., the U.K., and other developed countries in terms of the capacity of scientific research, and the quality of teaching and learning, which have continually attracted foreign students to pursue graduate degrees in these countries (Altbach, 2004a; Nerad, 2010). Nevertheless, recent rankings of global graduate schools have witnessed a strong surge of graduate schools from other countries and regions, in particular those from Asian countries such as China, Singapore and Malaysia, over the past two decades (Lee et al., 2020; University World News, 2022). Favorable national policies, heavy investment in Research and Development (R&D), a strong focus on STEM disciplines, and diaspora have all contributed to the development of graduate education in the emerging competitive graduate education systems including China (Altbach et al., 2012; Cheng & Liu, 2006; Lee et al., 2020).

In the case of China, exploring graduate education policies and practices has been in the agenda of Chinese government since the founding of the People's Republic of China in 1949. However, the piloting practice of graduate education in the 1950s, although being important and helpful explorations, was confined to a small-scale trial with limited educational quality (Zhao, 1999). An early version of the official national graduate degree policy was written in 1964; although, it was not fully executed due to various reasons. Since the restoration of graduate education in 1978, it has gone through arduous trials and continual improvement (Wang & Yang, 2019; Zhao, 2001). The growth of Chinese graduate education has kept pace with the development of the nation by aligning with national strategic planning, serving the economic and social needs, and cultivating high-level talent (Wang et al., 2019). Through both learning the best practices from other leading countries and active innovation and fine-tuning of the educational system to meet domestic and local needs, Chinese graduate education has created and established a comprehensive system that embodies unique Chinese characteristics, growing in both quantity and quality (Wang, 2019; Wang & Zhang, 2019).

After the issuing of the *Notice on Recruiting Graduate Students in Higher Education Institutions in 1977*, 10,000 graduate students were recruited and enrolled in 1978 (Wang & Yang, 2019). The document of *Degree Regulations of the People's Republic of China* was issued in 1980 along with additional policies for implementation, signifying the official establishment of Chinese graduate degree system (National People's Congress, 2004). The first group of 18 doctoral degree recipients were awarded and celebrated in 1983 (Chen, 2013).

With the official establishment of the Chinese postgraduate degree system, multiple reformatory policies and measures were launched. These policies included founding graduate schools within higher education institutions, issuing and adjusting the list of disciplines for awarding graduate degrees, organizing different levels of graduate degree committees and other administrative measures. Through these efforts, the Chinese graduate degree system has been continually developing and optimizing itself.

After the 1990s, Chinese graduate education has entered a stage of rapid development, which took place together with the fast economic growth and technological progress of the Chinese society. Due to the favorable national policy issued in 1999 expanding the recruitment of higher education (Ministry of Education [MOE], 1999), the average annual growth of graduate degrees awarded had remained higher than 25% between 1999 and 2007 (National Bureau of Statistics, 2008). The average annual growth of doctoral degrees was 19.7% and that of master's degrees was 27.4%.

The establishment of a series of national-level graduate educational policies on various aspects of graduate education have set the foundation for such development. National policies covered aspects of graduate education such as educational quality assurance, the creation of professional graduate degrees, and the assessment and evaluation of degree-granting programs. In addition to national-level guiding policies, the active experimentation of pioneering institutes and universities, such as Chinese Academy of Sciences (CAS), University of Science and Technology of China (USTC) and Tsinghua University (THU), have also explored suitable graduate education practices adapted to the social and economic needs of China. Moreover, practitioners and scholars have been actively exploring the teaching, learning and administration of graduate education, and analyzing and summarizing the challenges and opportunities in practice, which also contribute to the proliferation of Chinese graduate education.

It should be noted that national policies that were geared towards higher education in general, although not targeting graduate education in specific, have also greatly facilitated the fast development of Chinese graduate education. In particular, national policies such as Project 211 (1995) and Project 985 (1998), along with the subsequent Double World-Class Project (2015), were critical initiatives launched by the Chinese government to enhance the academic and research quality of key Chinese universities with the goal of becoming world-class universities (MOE, 2008; the State Council, 2015). The projects supported the development of universities by allocating sufficient funds, issuing preferential policies and the support of other resources (MOE, 2008; MOE et al., 2017). In addition to the policies promoting the overall development of higher education, special policies and measures targeting graduate education have also played an important role. Through this process, Chinese graduate education has benefited tremendously from such targeted support and flourished over the past twenty years. The scale and quality of Chinese graduate education have experienced an unprecedented increase which will be delineated in-depth in this chapter.

In this chapter, through an overview of data on the development of Chinese graduate education placed in comparison to the current leading graduate education systems, this chapter attempts to offer an overall understanding of the recent trends in the development of Chinese graduate education. Using a set of excellence indicators, this chapter situates the Chinese graduate education system in the context of global comparison with the existing advanced graduate education systems. In addition to an overall and comparative look of the system, this chapter further zooms into the Chinese graduate education system by highlighting the unique features, introducing the best practices, and providing in-depth stories about the development of selective universities or graduate schools to showcase the developmental processes. Moreover, a synthesis of current literature of the past 10 years offers an understanding of the recent trends on key research findings concerning graduate education among mandarin literature. Finally, the evolution of Chinese national policies related to graduate education is described to illustrate the various aspects of supports that have been provided by the national government.

2 Highlighting Data

2.1 Number of Graduate Degrees Awarded

The number of graduate degrees awarded by Chinese institutions in 2021 was 772,800, an increase from 767,984 in 2020, according to the data provided by Chinese MOE. Among them, around 90.68% of students were awarded master's degrees, and 9.32% were doctorate recipients (MOE, 2020a, 2022).

Figures 1 and 2 depict the growth curves for doctoral degrees and master's degrees awarded in China from 2010 to 2021. Figure 3 shows the growth curve for total graduate degrees awarded from 2010 to 2021. As shown in Fig. 3, the overall number of graduate degree holders doubled compared to that of 2010. More specifically, the number of doctoral degree recipients climbed from 47,407 in 2010 to 72,000 in 2021, and the number of master's degree recipients rose from 332,585 to 700,700.

From 2010 to 2021, the average annual growth rate for the number of graduate degree holders is about 7.36%; the average annual growth rate for the number of doctoral degree holders is about 4.27%; the average annual growth rate for the number

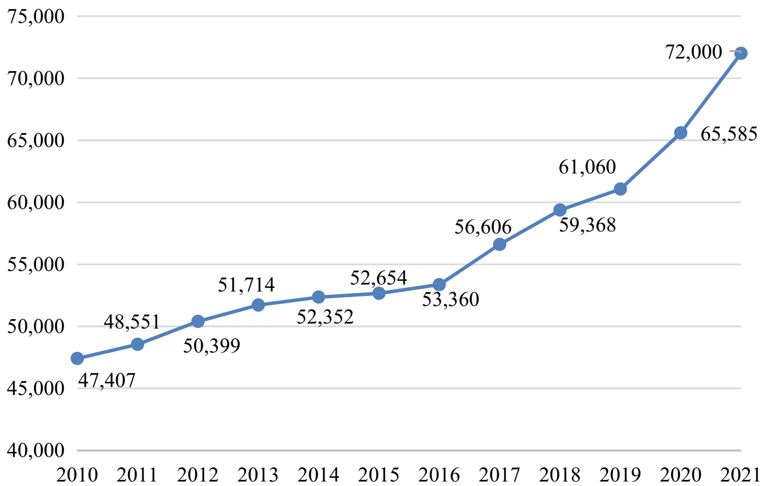


Fig. 1 Number of doctoral degrees awarded (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

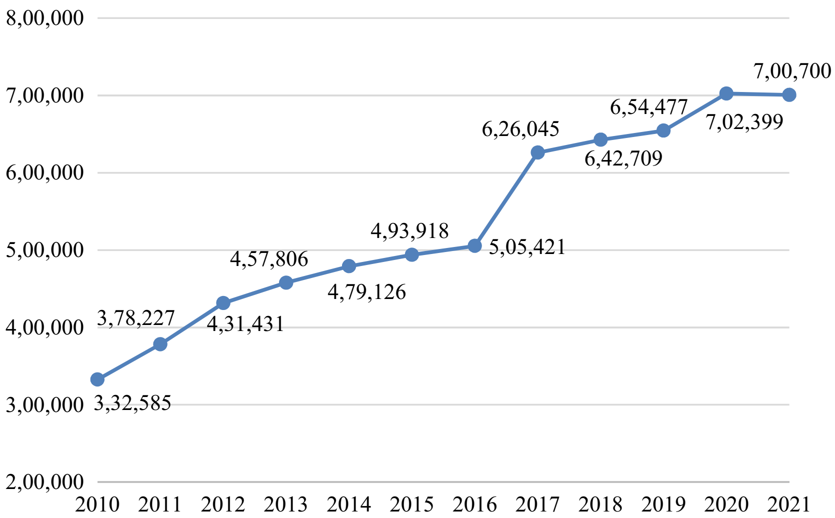


Fig. 2 Number of master's degrees awarded (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

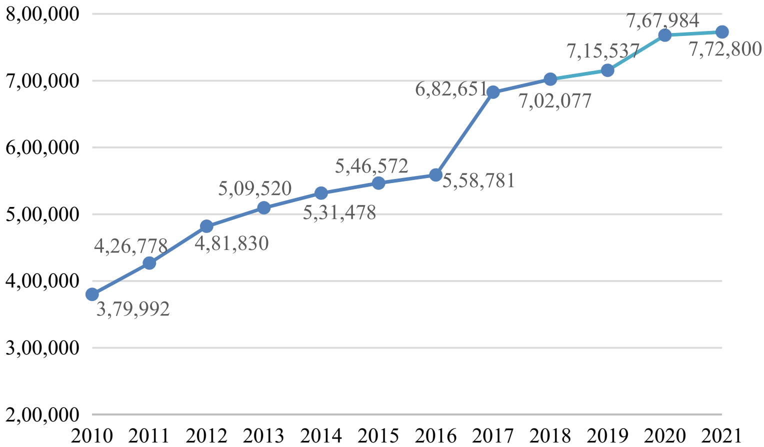


Fig. 3 Number of graduate degrees awarded (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

of master's degree holders is about 7.74%. The growth rate of master's degrees has been much faster than that of doctoral degrees.

Figure 4 depicts the number of graduate degree holders in ten different countries in 2019. Compared to leading countries in graduate education, including the U.S., the U.K., Japan, Germany, Australia, Canada, France, the Netherlands, and the Republic of Korea (ROK), China is now the second-largest country in terms of the number of master's and/or doctoral degrees awarded every year. These numbers were preceded

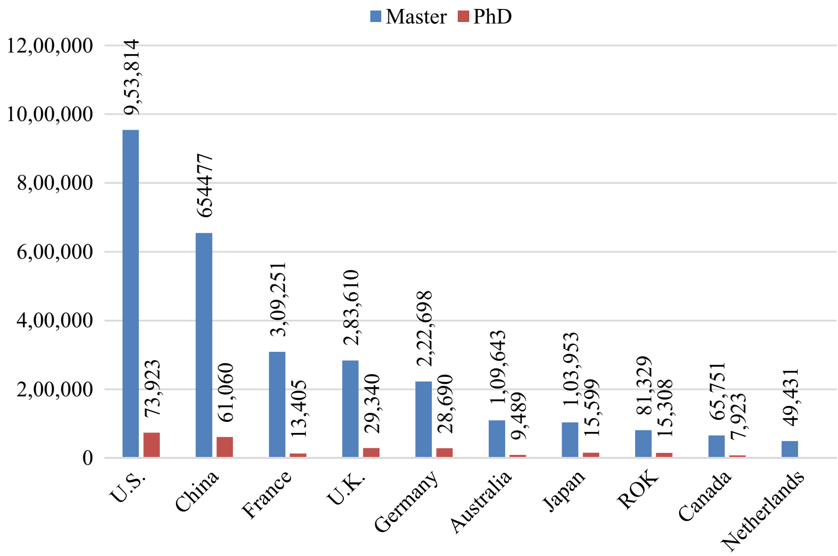


Fig. 4 Number of graduate degrees awarded by ten major countries in 2019. *Source* OECD (2019a), MOE (2019a)

only by the U.S. with 953,814 students awarded master's degrees and 73,923 doctoral degrees in 2019.

2.2 Total Enrollment of Graduate Students

In terms of the number of graduate students enrolled in China in 2021, there were 1,050,700 students admitted to master's programs, and 125,800 to doctoral programs. The total enrollment number has reached over one million (1,176,500) in 2021 in China (MOE, 2022). From 2010 to 2021, the average annual growth rate of the number of enrolled graduate students is about 8.14%, the average annual growth rate of enrollment number at the master's level about 8.28% and the average annual growth rate of enrollment number at the doctoral level about 7.03%.

Figures 5 and 6 show the growth curves of the enrollment of doctoral-level and master-level students from 2010 to 2021. Figure 7 shows the growth curve of the total enrollment of graduate students from 2010 to 2021.

Compared to the enrollment of graduate students in the leading countries in graduate education, China ranked fourth, following the US, Germany, and France (Fig. 8). As China ranked second for the number of graduate degrees awarded, this may represent higher completion rates for master's and doctoral degrees in China.

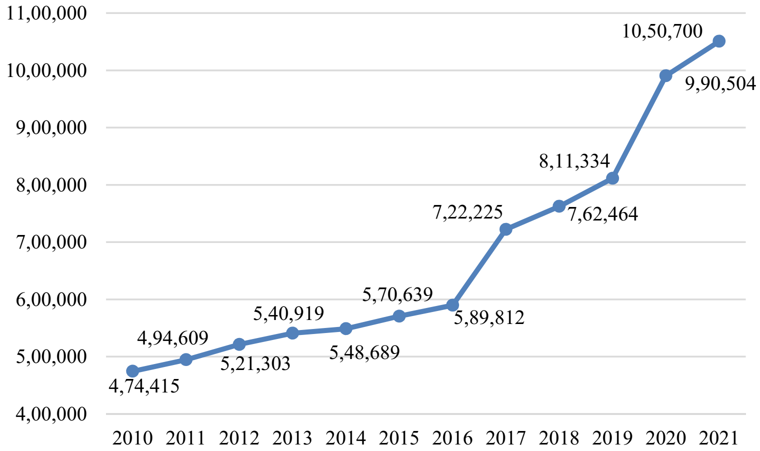


Fig. 5 Number of enrolled master-level students (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

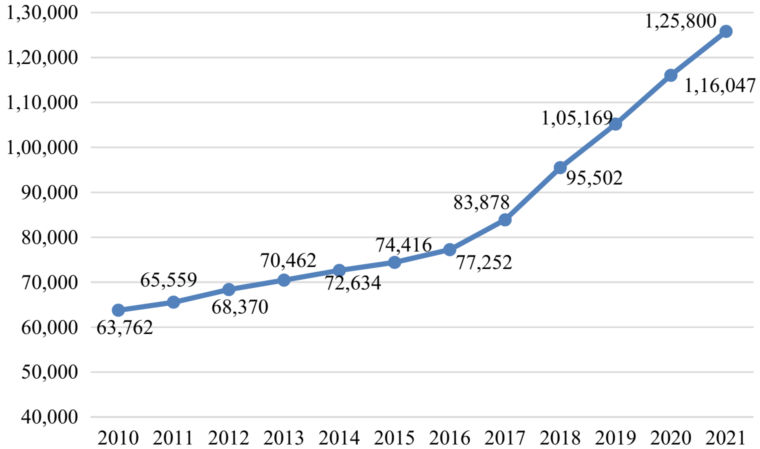


Fig. 6 Number of enrolled doctoral-level students (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

2.3 Ratio of Doctoral Degrees to the Total Graduate Degrees

Compared to other countries, China has a relatively lower percentage of doctoral degrees awarded, which was about 8.53% in 2019 (see Fig. 9). The top three countries that have the highest percentages of doctoral degrees among all graduate degrees are ROK (15.84%), Japan (13.05%) and Germany (11.41%).

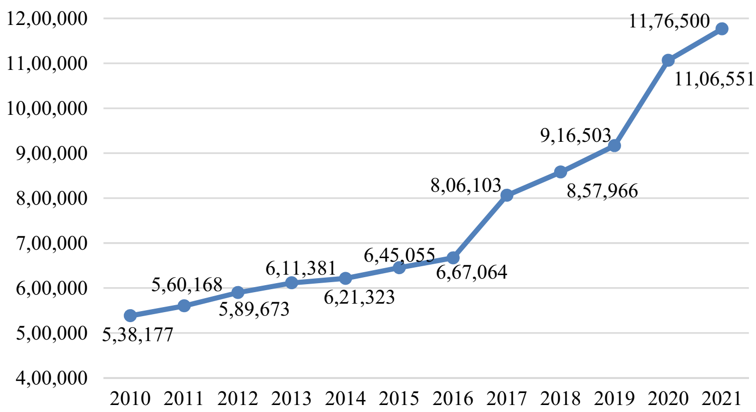


Fig. 7 Number of total enrollments for graduate students (2010–2021). *Source* MOE (2010a, b, 2020a, 2022)

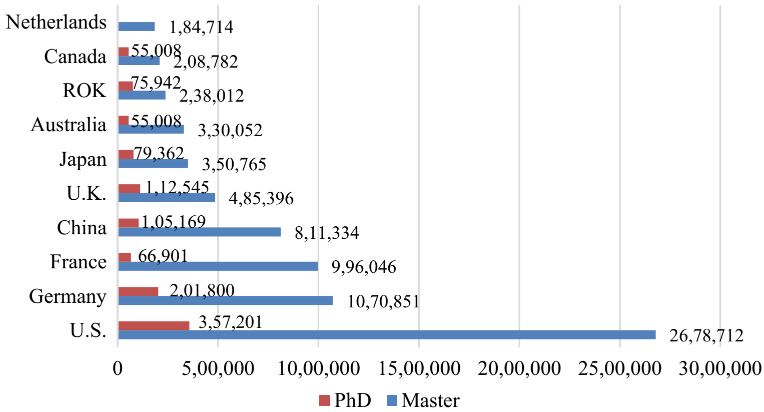


Fig. 8 Total enrollment of graduate students in 2019. *Source* OECD (2019b), MOE (2019a)

2.4 Workforce (25–64 Year-Olds) with Graduate Education Attainment

As shown in the prior data, the scale of graduate education is rapidly increasing in China. However, the ratio of population among the labor force (e.g., 25–64 year-olds) that has graduate degree attainment is relatively low. According to the "General Census" conducted in 2020, only around 1.11% of the population in China aged 25 – 64 hold master's degrees or doctoral degrees (see Fig. 10). In comparison, the OECD average of 25–64 year-olds population that hold master's degrees or doctoral degrees were approximately 13.5% and 1.3% respectively in 2020 (OECD, 2021a).

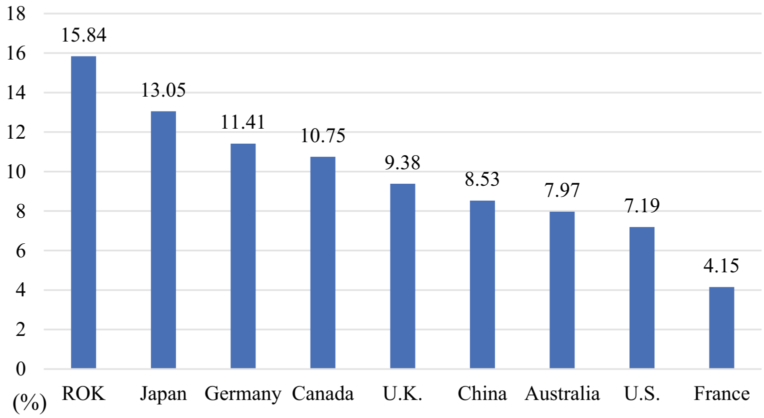
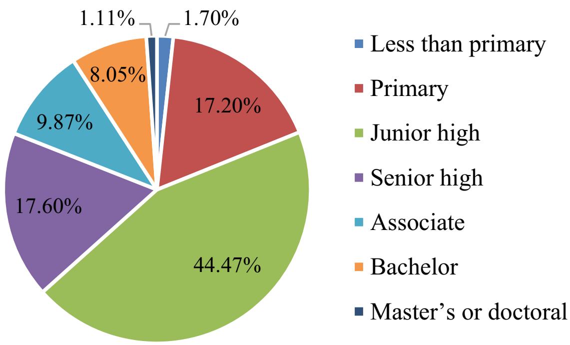


Fig. 9 Percentages of doctoral degrees awarded compared to all graduate degrees awarded in 2019. *Source* OECD (2019a), MOE (2019a)

Fig. 10 Educational attainment of 25–64 year-olds in China in 2020. *Source* National Bureau of Statistics (2021)



The percentage of graduate education attained in China is the lowest among the listed countries (see Fig. 11). The top three countries that have a labor force with the highest ratio of graduate education attainment were the Netherlands, the U.K., and the U.S. Despite the expansion in the scale of Chinese graduate education, the graduate education attainment among Chinese labor force is yet to be increased. In this sense, this chapter might expect a further increase in the scale of Chinese graduate education in the near future.

2.5 Student-Faculty Ratio

The student-faculty ratio is considered to be a proxy of quality in graduate education, as students are more likely to receive greater support and attention when the ratio is low. In China, with the restoration of graduate education since 1978, the number of

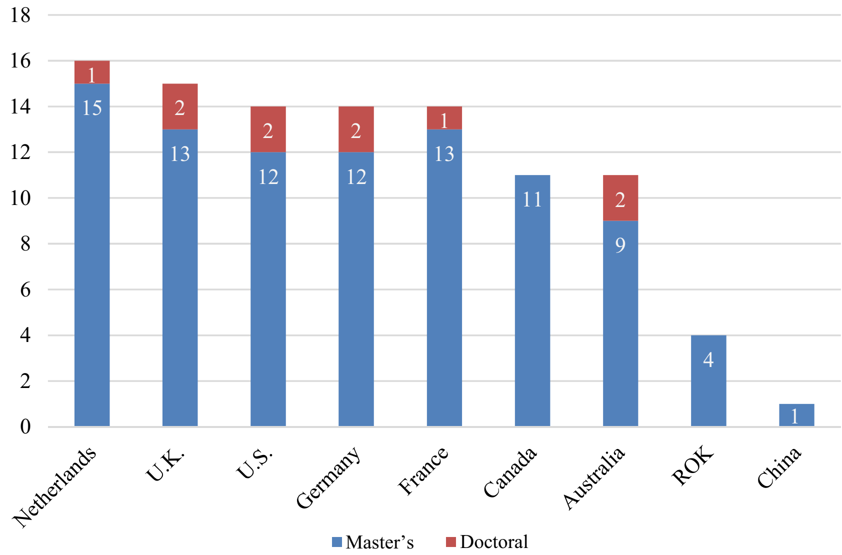


Fig. 11 Graduate educational attainment of 25–64 year-olds (%) in 2020. *Source* OECD (2021a), National Bureau of Statistics (2021)

graduate supervisors is also on the rise (Fig. 12), with an average annual growth rate of 7.24% between 2010 and 2020. Meanwhile, the total number of graduate students at school has been increasing between 2010 and 2020 (Fig. 13) with an average annual growth rate of 7.39%.

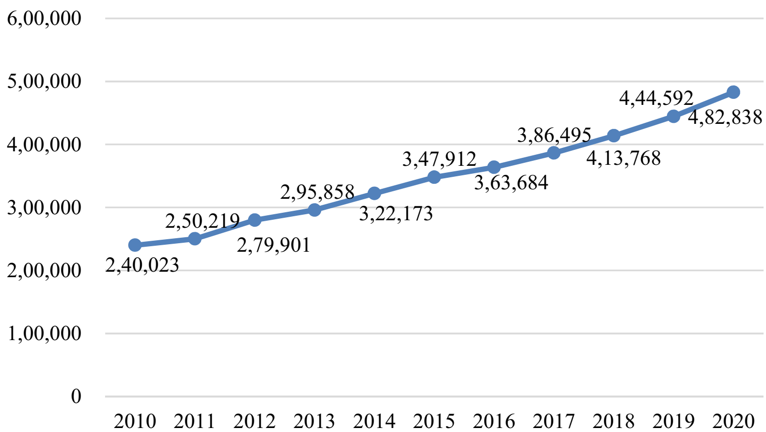


Fig. 12 The number of graduate supervisors (including advisors to master's and doctoral students) for graduate students in China (2010–2020). *Source* MOE (2010a, b, 2020b)

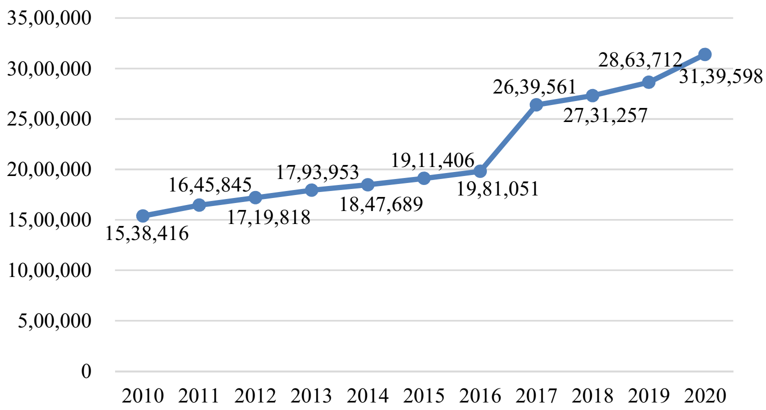


Fig. 13 The growth curve of the number of graduate students in school (including master's and doctoral students) in China (2010–2020). *Source* MOE (2010a, b, 2020a)

With comparable annual growth rates for both in-school graduate students and supervisors, the graduate student-supervisor ratio remained approximately 6:1 between 2010 and 2020 (Fig. 14). In 2010, the ratio was 6.41:1. From 2010 to 2020, the overall ratio saw a slight decrease, with the lowest number (5.45:1) in 2016, which was followed by another increase. In 2020, the ratio of graduate students to supervisors was around 6.5:1, with 482,838 supervisors and 3,139,598 graduate students at school.

When compared to the data from OECD, the student-faculty ratio of Chinese higher education is close to other leading higher education countries. It should be noted that the faculty number here refers to faculty members at bachelor, master, and

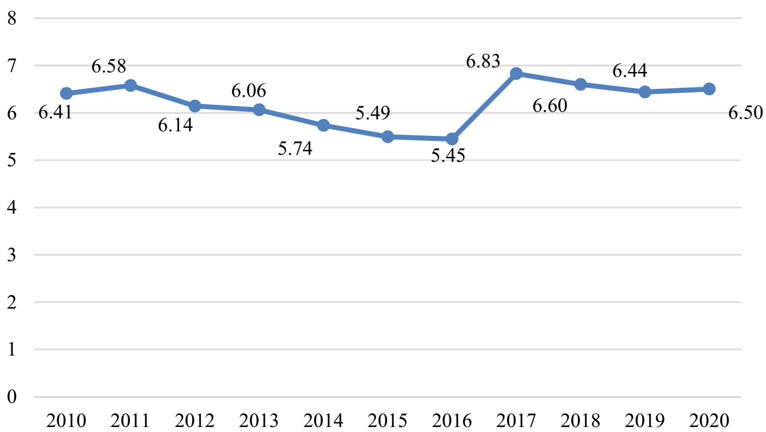


Fig. 14 Graduate student-supervisor ratio for graduate students in China (2010–2020). *Source* MOE (2010a, b, 2020b)

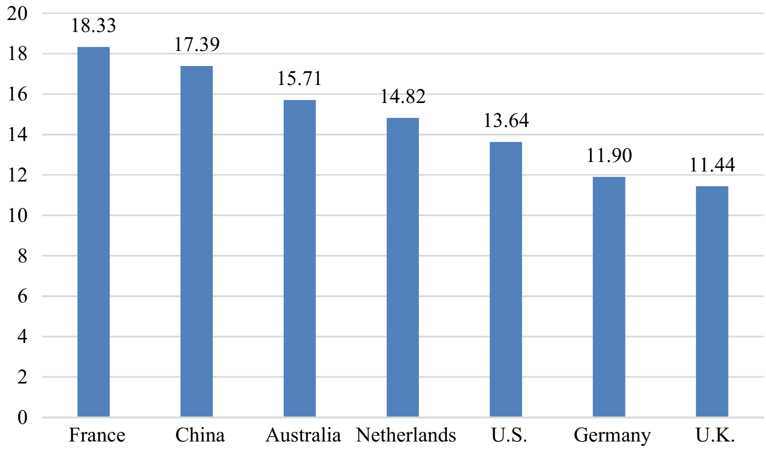


Fig. 15 Student-faculty ratio in higher education in 2019. *Source* OECD (2021b), MOE (2020b)

doctoral levels, instead of just graduate supervisors. As shown in Fig. 15, the top three countries with the highest student-faculty ratio are France, China, and Australia.

2.6 Number of International Students in Graduate Education

The ability to attract international students has been an important indicator for the quality of graduate education. China has become one of the most popular study destinations globally. According to The Open Doors Report 2019 (Institute of International Education, 2019), China, still being one of the largest home countries to send students abroad, has now become the third largest host country for international students (the top two being the U.S. and U.K.). In 2018, there were 492,185 foreign students studying in China, with 258,122 of them pursuing a degree (more than 50%) (MOE, 2019b). When compared with 2017, the number of students studying for a graduate degree increased by 12.28% and reached 85,062. Among them, 59,444 students were studying for a master's degree, and 25,618 were studying for a doctoral degree (MOE, 2019b). The last decade has witnessed a rapid increase in the enrollment of international graduate students, which increased from 18,978 in 2009 to 85,065 in 2018 (MOE, 2019b). The average annual growth rate is approximately 20.59%. See Fig. 16 for more detailed information.

Since the initial attempt of international student enrollment in 1954, the number of international students studying for a graduate degree in China has grown steadily (Chen, 2008). However, the exact data were not clearly documented until 1986, when 26 international students came to China for graduate studies according to the record. The data soared to 53 and 104 in the following two years. As can be seen clearly in Fig. 16, there was an exponential growth trend in the number of international

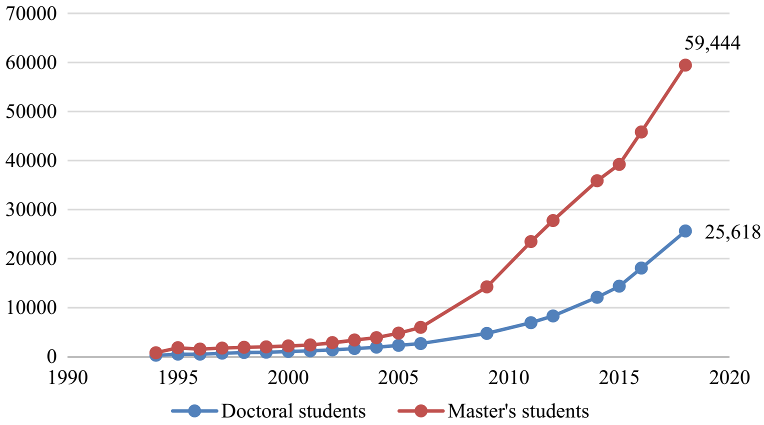


Fig. 16 Number of international graduate students enrolled (1994–2018). *Source* MOE (1994–2019)

students between 1994 to 2018—nternational graduate students increased steadily before 2010 and soared afterwards. This was mainly due to the Study in China Plan published by MOE in September 2010 (MOE, 2010a). The goal of this plan was to increase the number of international students coming to China and to promote the sustainable and healthy development of international student outreach.

Despite the fast pace of the international graduate education expansion, due to the large graduate student population in China, international graduate students only represent a small proportion, around 10% for Double World-Class universities.

Regarding the ethnicities of international students enrolled in Chinese higher education (including all types of students in higher education institutions at both undergraduate and graduate levels), Asian students constituted the largest group, probably due to the cultural similarities and proximity of the countries. As shown on MOE's website, ROK, Thailand, and Pakistan sent the most students (50,600, 28,608, and 28,023 respectively). In terms of financial support, 12.81% of the students were funded by the Chinese government, whereas 87.19% were self-supported or financed by other resources (MOE, 2019b).

2.7 *Research and Development (R&D) Funding in Higher Education*

In 2019, the Chinese government supported a broad range of scientific and engineering R&D activities, with total funding of RMB2,214.36 billion (approximately US$346 billion) in all sections (National Bureau of Statistics, 2020). Among the 2,214.36 billion, RMB179.66 billion was invested in higher education, an increase of 23.2% above the 2018 level of 145.79 billion (about US$22,779 million) (National

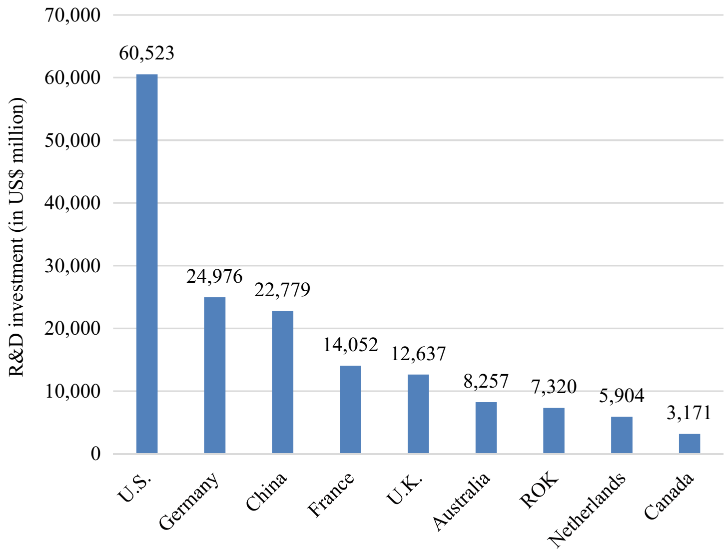


Fig. 17 R&D expenditure for higher education (2018) (in US$ million). *Source* OECD (2019c), National Bureau of Statistics (2019)

Bureau of Statistics, 2020). China ranked third for the R&D funding of higher education among the 10 countries previously mentioned (see Fig. 17). The R&D investment of higher education in China is about one-third of the funding level in the U.S. (US$60,535 million).

2.8 *The Volume of Academic Research Publications*

Producing high quality research publications has been an important indicator for the quality of academic research in graduate education. Among the common indexing for research journals, SSCI and SCIE that were developed by Clarivate have been widely used as a measure for citations of research journals. According to the data from Web of Science (WOS), the total number of research articles that were published in Social Sciences Citation Index (SSCI) and Science Citation Index Expanded (SCIE) by Chinese scholars in 2021 ranked top among the listed countries (see Fig. 18). Meanwhile, the number of research articles that were published in SSCI and SCIE by Chinese scholars have been increasing over the past decade (see Fig. 19).

In summary, highlighting data in this section were used to showcase the recent development Chinese graduate education. In a sense, the panel data and the trends of key developmental data of Chinese graduate education over the past decade that were illustrated here point to the increase of both quantity and quality of Chinese

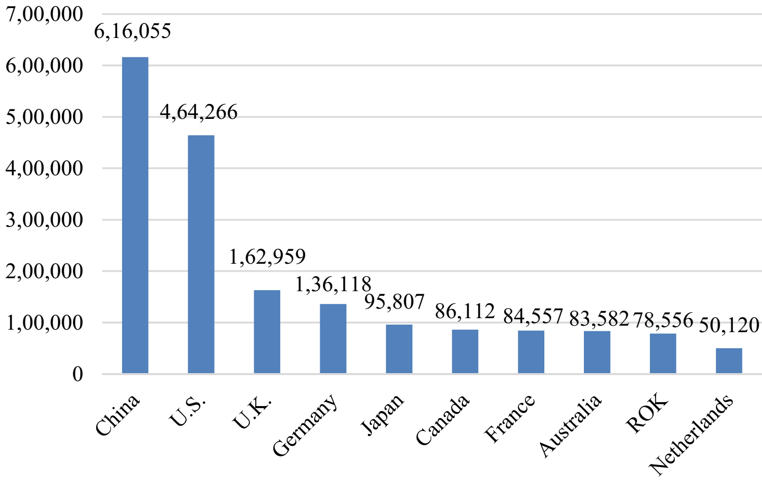


Fig. 18 The number of research publications by scholars from different countries (2021). *Source* WOS (n.d.)

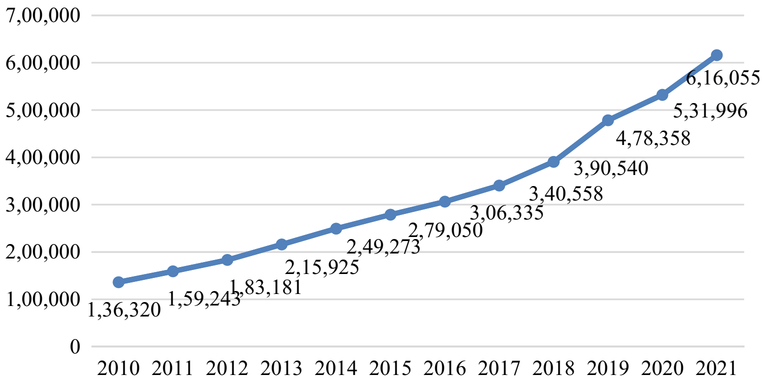


Fig. 19 The number of research publications by scholars of China (2010–2021). *Source* WOS (n.d.)

graduate education, in particular through a comparison to the data from the current leading graduate education systems.

3 Excellence Indicators

3.1 Design

To provide a comparative understanding of the Chinese graduate education system, this chapter designs a set of graduate education excellence indicators to capture the development of graduate education systems of several benchmarking countries in selective dimensions. In specific, the excellence indicators are designed to capture the capacity of a certain nation to provide high quality graduate education.

The design of the excellence indicators follows three principles—comparability, accessibility, and representativeness. In terms of comparability, chosen indicators should showcase some feature or characteristic of graduate education systems which can be compared with that of other existing graduate educational systems. To satisfy the principle of accessibility, the source data of a chosen indicator for a particular graduate educational system should be readily available or can be obtained via simple calculations from public websites or databases. In terms of representativeness, it is expected that the chosen indicators can reflect some feature of a particular dimension (e.g., performance or scale) before being counted as an indicator for that dimension.

After a careful search of available databases both globally and locally for graduate educational systems in different nation states, along with a synthesis of existing comparative studies of graduate educational systems across countries (Liu & Wang, 2012; Wang, 2015; Wang & Li, 2012; Zhao & Wang, 2013, 2015), the excellence indicators are finalized with ten indicators from three dimensions. More specifically, the design of excellence indicators covers the performance, scale, and resource dimensions of a graduate educational system for a particular country or region. The detailed definitions and source data for each indicator within the three dimensions are covered below.

3.2 Definitions and Sources

Overall, there are ten specific indicators in three different dimensions (Performance, Scale, and Resource) (Table 1). The specific indicators and the respective data sources are listed according to their dimensions.

In the performance dimension, specific indicators include, the ratio of doctoral degrees to the total graduate degrees, the annual growth rate of enrollment of graduate students over the past five years, attainment of graduate education among 25–34 year-olds (defined as the ratio of 25–34 year-olds with graduate degrees), the number of journal publications that were indexed in the SCIE or SSCI, the ratio of international graduate students (defined as the average of the ratio of master-level international students and the ratio of doctoral-level international students), and the ratio of people possessing graduate degrees among the workforce (defined as the total percentage of people with graduate degrees among 25–64 year-olds). In the scale dimension, a

Table 1 Specific dimensions of the graduate education excellence indicators

Dimensions	Indicators	Data sources
Performance	1. Ratio of doctoral degrees to the total graduate degrees	OECD
	2. Annual growth rate of enrollment of graduate students over the past 5 years	OECD
	3. Attainment of graduate education among 25–34 year-olds (Ratio of 25–34 year-olds with graduate degrees)[1]	OECD
	4. Number of journal publications that were indexed in the SCIE or SSCI	WOS
	5. Ratio of international graduate students	OECD
	6. Ratio of people possessing graduate degrees among the workforce	Chinese human capital report/ OECD
Scale	7. The number of graduate degrees granted	OECD
Resource	8. Student-faculty ratio	OECD
	9. R&D fund	OECD
	10. Ratio of institutions/universities that ranked in the top 50 versus the total number of institutions/universities in a country[2]	Academic Ranking of World Universities (2021)

Notes
1 More specifically, it was defined as the ratio of 25–34 year-olds with master's degrees because the source data have quite a few missing data at the doctorate level
2 Due to the differences in statistical methods used to count the number of institutions in different countries, this indicator was substituted via the ratio of institutions and universities that ranked in the top 50 versus the total number of institutions and universities that entered the Academic Ranking of World Universities (ARWU) in 2021 in a particular country

specific indicator includes the number of graduate degrees granted. In the resource dimension, indicators include student-faculty ratio, R&D funds (defined as expenditures in R&D activities in tertiary education), the ratio of institutions/universities that ranked in the top 50 versus the total number of institutions and universities in a country (operationally defined as the ratio of institutions and universities that ranked in the top 50 versus the total number of institutions and universities that entered the ARWU in 2021 in a particular country (ShanghaiRanking, 2021).

It should be noted that all data are obtained first as raw data in its original units. Such data are then normalized to a 0–100 scale, representing the highest score as 100. Also, since the source data for two indicators – the annual growth rate of enrollment of graduate students over the past five years and the ratio of international students—tend to be clustered at a certain range, it is reasonable to classify them into data ranges rather than normalizing the source data. In this case, the source data that is in the highest level is counted as 100.

3.3 Findings

Together, this chapter compares ten countries' graduate education using the excellence indicators. These ten countries are selected based on an understanding of current existing literature about the general development of graduate education of different countries (Altbach, 2004b; Nerad, 2010). The 10 countries include, the U.S., the U.K., Germany, France, the Netherlands, Australia, Canada, Japan, ROK, and China. Via the calculation of respective indicators in each dimension, scores of the excellence indicators were obtained for the listed ten countries (Table 2). Through a comparison of the scores, the ten countries were sorted according to their respective average scores. A sorted list of the ten countries is presented in Fig. 19 using their average scores.

Through an overall comparison across the ten countries, as shown in Fig. 20, the U.S. with a score of 74.74, is ranked in the top position. France and the U.K. rank in the second and the third places respectively. Several European countries follow the top three ranks. China, with a score of 48.24, is ranked in the sixth position of the list followed by Japan, Australia, Canada, and ROK.

As shown in Table 2, Chinese graduate education system has shown its competitiveness by leading in several indicators. First, China ranks at the top of the list in two indicators: the annual growth rate of enrollment of graduate students over the past five years and the number of journal publications that were indexed in the SCIE or SSCI. Meanwhile, Chinese graduate education system ranks second for the student-faculty ratio, behind France. Also, the difference between the scores (100 vs. 95) indicates a close gap between the actual number of faculty-student ratios of the two graduate education systems. In addition, China also ranks second for the number of graduate degrees granted, behind the U.S. Considering the difference between the scores (100 vs. 76), the number of graduate degrees granted in Chinese graduate education system was only about 3/4 of the number of the U.S. system. Moreover, following the U.S. and Germany, China ranks at the top 3 for the R&D fund. Comparing the differences between the scores (100 for the U.S., 41 for Germany and 38 for China), it can be concluded that the U.S. continues to lead in its investment for R&D fund in higher education.

On the contrary, there are also several indicators in which Chinese graduate education system ranked poorly, including the attainment of graduate education among 25–34 year-olds, the ratio of international graduate students, the ratio of people possessing graduate degrees among the workforce, and the ratio of institutions/universities that ranked in the top 50 versus the total number of institutions/universities in a country. In all four indicators, China ranks at the bottom of the list.

Finally, for the ratio of doctoral degrees to total graduate degrees, China, along with countries like the U.S., the U.K, rank in the middle of the list. ROK and Japan rank as the top two countries in this indicator, suggesting greater emphasis on doctoral education despite of the small scale of the two systems.

Table 2 Standardized scores of the graduate education excellence indicators and respective average scores for the listed ten countries

Countries	U.S	France	U.K	The Netherlands	Germany	China	Japan	Australia	Canada	ROK
Indicator 1	45	26	59	N/A	72	54	82	50	68	100
Indicator 2	12.5	25	25	50	25	100	25	37.5	25	12.5
Indicator 3	50	100	65	90	70	5	N/A	45	55	15
Indicator 4	75	14	26	8	22	100	16	14	14	13
Indicator 5	100	100	100	100	100	0	100	100	100	100
Indicator 6	90	88	92	100	87	6	N/A	62	N/A	N/A
Indicator 7	100	25	35	3	31	76	16	12	9	15
Indicator 8	74	100	62	81	65	95	N/A	86	N/A	N/A
Indicator 9	100	23	21	10	41	38	N/A	14	5	12
Indicator 10	100	71	77	55	14	9	38	21	51	0
Total score	747	573	562	496	528	482	277	441	327	267
Average score	74.74	57.28	56.23	55.14	52.79	48.24	46.09	44.07	40.86	33.37

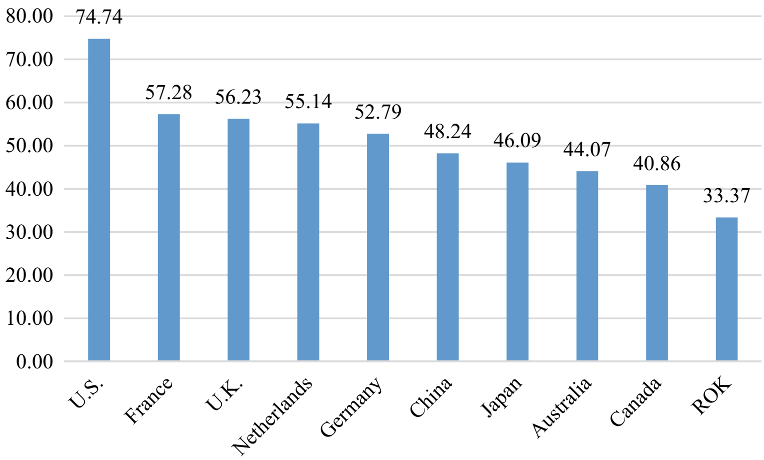


Fig. 20 A sorted list of the ten countries using their respective average scores of the graduate education excellence indicators

3.4 Discussions

In summary, using the graduate education excellence indicators provides a comparative view of the graduate education systems of different countries. Based on the comparison of the various indicators, it is noticeable that through the development of graduate education over the past forty decades, Chinese graduate education has seen a dramatic increase in both its quantity and quality.

First, Chinese graduate educational system excels in two indictors: the annual growth rate of enrollment of graduate students over the past five years and the number of journal publications that were indexed in the SCIE or SSCI. Concerning the annual growth rate of enrollment of graduate students over the past five years. Such a rapid growth rate is closely related to China' national educational policies to increase the overall scale of higher education. The policy to expand the enrollment of both undergraduate and graduate level students began in 1999 (MOE, 1999a, b, c). The purpose of this policy is to increase the pool of high-quality talent and relieve the pressure of employment on young people (Li & Chen, 2006). This policy has been regarded widely as one of the most popular policies of the year due to the increased opportunities for more students to access higher education (Wang et al., 2019). The fast growth of graduate enrollment is tightly connected to the relatively high number of graduate degrees granted, in which China ranks in the top two as compared to other existing graduate education systems, second only to the U.S.

Concerning the leading position of China in the number of journal publications that were indexed in the SCIE or SSCI, prior studies have pointed out that such a growth in research output has benefited from the overall Chinese economic growth and Chinese government's national policies to promote investment to science and technology to support the economic growth continually (Xie et al., 2014; Yang & Welch, 2012).

Moreover, the fact that China is now producing more scientists and engineers at both the undergraduate and graduate levels has facilitated the increase of research output. Meanwhile, multiple programs have been launched to attract established Chinese scholars in science and engineering internationally (MOE, 2010b). Such programs have attracted a legion of Chinese talents overseas to join the academic research of science and technology in Chinese universities and institutes (Li et al., 2015). The increasing returnees in academia and the increasing local science and engineering degree holders have together contributed to the fast research output of Chinese higher education (Huang, 2003; Yang & Welch, 2010).

Despite China's leading position in the growth rate of graduate enrollment and the overall number of graduate degrees conferred, China lags behind in the attainment of graduate education among 25–34 year-olds and the ratio of people possessing graduate degrees among the workforce, ranking at the bottom of the listed ten countries. The overall large quantities of graduate degree holders, divided by the large population, lead to relatively low number of degree holders among the general population. With China's increasing need for economic development and a high-quality workforce, it can be expected that the increase of graduate enrollment and the overall number of graduate degrees conferred will be sustained in the Chinese graduate education system in the near future.

Although the total number of Chinese institutions/universities has been steadily increasing in the competitive rankings, the ratio of institutions/universities ranked in the top 50 versus the total number of institutions/universities (for example, in the ARWU) has been quite low for China, lagging far behind all of the listed countries. Seven universities in China entered the top 50, compared to 20 in the U.S. in 2021, according to the ARWU. On the other hand, China has quite a large number of institutions that entered the top 1,000 group. A total number of 157 universities are in the top 1000, while the U.S. has 200 universities listed in the top 1,000. As mentioned before, multiple strong national policies have supported the development of key universities in China, such as Project 211 and Project 985, and the latest Double World-Class policies. With continual favorable national policies, along with multiple other factors that shall be discussed in the later sections, one would expect the ratio of Chinese institutions/universities that ranked in the top 50 versus the total number of institutions/universities to continue to improve in the near future.

The attractiveness to international students has been one of the key indicators for the competitiveness of graduate educational systems (Wen et al., 2014). However, it appeared in the data that for the Chinese graduate educational system, the ratio of international graduate students remained far behind all of the other listed graduate educational systems. It should also be noted that, according to the data reported by the Institute of International Education, China has risen as the third largest destination for international students, including the graduate-level international students. To some degree, the increase in the number of international students has implied a rising competitiveness of China as an attractive destination for pursuing graduate degree. Reasons such as stable political environment, favorable scholarship policies, fast economic development, and quality research facilities and platforms, have all contributed to international graduate students' decision for choosing Chinese universities (Zhang & Zhu, 2020). In addition, Chinese universities have been steadily improving in the rankings of graduate schools, especially in disciplines in science and engineering. Therefore, although the ratio of international students is still behind the ratio in other existing systems, such as about 25% in the U.S. and 40% in the U.K. (OECD, 2019d) at the doctoral level, it can be expected that more international students will choose Chinese graduate educational system in future.

4 Best Practices

With four decades' experiences in graduate education after the restoration of graduate education in 1978, China has gradually developed a system of graduate education that embodies some unique features while learning from the best practices of existing systems in other countries. The Chinese graduate educational system has demonstrated its unique features in a number of policy measures and related practices. These policies and practices in graduate education include the establishment of a systematic quality assurance structure along with various quality assurance measures, innovations in the recruiting procedures, and autonomy in establishing graduate degree programs for selected universities and the dynamic adjustment of graduate degree programs.

4.1 Building a Systematic Quality Assurance System

The idea of establishing a systematic quality assurance structure was formally proposed in a governmental document – *Guidelines on Strengthening the Degree and Graduate Education Quality Assurance and Monitoring System* (The Degrees Committee of the State Council & MOE, 2014a). This governmental document officially put forward a "five-entity one-structure" quality assurance system that consists of five major entities in graduate education. These key entities include degree-granting institutions, educational administrative departments, academic organizations, industrial organizations, and other social organizations. Within this structure, the degree-granting institutions play a fundamental role in ensuring the quality of education while the educational administrative departments guide the general direction. Meanwhile, academic organizations, industrial organizations, and other social organizations actively engage in the quality monitoring process.

The policy document sets its focus on the quality of graduate education. The key policies aim at switching the roles and functions of the government and allowing more autonomy and power for the degree-granting institutions. To do so, it emphasizes the separation of the different roles of administration, implementation, and assessment of graduate education, highlighting the autonomous and central roles of degree-granting institutions. The policy requires degree-granting institutions to take a more proactive role in accountability by establishing internal quality assurance systems, drafting quality standards for graduate education according to the institutions' goals, and building a sound mechanism for resource allocations (e.g., graduate assistantships) that centered on improving educational quality.

Such empowerment further extends within degree-granting institutions by putting the responsibility of quality assurance on departments and faculty members within universities and institutes. By centering graduate education on the relationships between graduate students and faculty members, this policy measure aims to stimulate the agency of the basic component-mentoring relationship-in graduate education. A number of additional policy documents were issued to ensure a healthy and effective mentoring relationship. For example, an official document was issued by MOE—*Guidelines on Accomplishing Graduate Supervisors' Roles and Responsibilities in Cultivating Virtues and Developing Talents* in 2018 (MOE, 2018a). The document emphasizes the importance and responsibility of graduate supervisors in overseeing graduate student development. With the issuing of this document, the mentor–mentee relationship in graduate education has received more and more attention in Chinese graduate education.

Overall, the document of *Guidelines on Strengthening the Degree and Graduate Education Quality Assurance and Monitoring System* was issued along with a series of other policy measures, which together aim to improve the quality of Chinese graduate education. Some of the other accompanying policy documents will be discussed further as follows (The Degrees Committee of the State Council & MOE, 2014a).

4.2 Random Inspection of Master's and Doctoral Theses

One of the accompanying measures was on the examination of masters' and doctoral students deposit theses via random sampling inspection. An official document named *Measures to Inspect Master's and Doctoral Deposited Theses through Random Sampling* was issued by the Degrees Committee of the State Council and MOE on 2014 (The Degrees Committee of the State Council & MOE, 2014b). This document designates the Degrees Committee of the State Council to be the entity that organizes the doctoral theses random inspection annually. The sampling of doctoral theses is retrieved randomly directly from the State Library. The percentage of sampling is set to be 10 percent. Master theses inspection will be coordinated by provincial-level offices of the Degree Committee. The percentage of sampling varies across different provinces.

Every inspected thesis shall be sent to three experts for double-blind reviews. If two or more out of three experts decide that a thesis did not meet the required standards, it will be scored as "failed". Institutions that have a high percentage of "theses with problems" will face warnings and possible suspension. Meanwhile, the results of inspection will be regularly provided to degree-granting institutions to improve their graduate education. Moreover, inspection results will be used as one of the key indicators for evaluating the qualification of degree-granting programs. The policy on the inspection of theses has created pressure for degree-granting institutions to closely monitor the quality of graduate education. Many institutions have set up their own double-blind theses inspection systems for increased internal quality control, increasing the percentage of sampling of theses for double-blinded review. Some institutions (e.g., Jiangsu University and Shanghai University) have extended the double-blind theses review process to 100 percent or all doctoral theses.

Within institutions, results are used to evaluate the qualifications of advisors. The results might also affect the allocation of relevant resources (e.g., enrollment quota of graduate students) for degree-granting programs in the institutions. For example, if an advisor had a student whose thesis was marked/rated as "failed", this advisor might be suspended regarding his/her qualification to recruit new graduate students for designated time period. The advisor's degree-granting program may also experience a cut in the enrollment quota of new graduate students according to policies set up by some graduate schools.

4.3 Periodic Evaluation of the Degree-Granting Programs

In addition to the results on the inspection of masters and doctoral theses, other relevant indicators were proposed to evaluate degree programs. Concerning the evaluation of the degree-granting programs, an official document on the evaluation process was first issued in 2014 with the latest version issued in 2020 by the Degrees Committee of the State Council. According to the latest version on *Measures to Evaluate the Degree-Granting Programs* (The Degrees Committee of the State Council & MOE, 2020a), there are two types of evaluation: designated evaluation and periodic evaluation.

Designated evaluation targets new degree-granting programs, while periodic evaluation applies to existing programs. New degree-granting programs will receive a designated evaluation three years after its establishment using a top-down evaluation. Existing programs complete periodic evaluation every six years. It should be noted that periodic evaluation is conducted in a manner that incorporates both self-evaluation and top-down sampling inspection. Self-evaluation is regarded as the primary method for periodic evaluation and quality improvement. In the process of self-evaluation, degree programs are required to establish a self-evaluation indexing system that can reflect their own characteristics in education. Detailed indicators can cover the number and quality of faculty members, the distribution of disciplinary fields, number and quality of graduates, research quality, social services, scholarly communications with other organizations, and indicators on infrastructures and regulatory structures. Internal and external experts will be invited to participate in the peer review process which includes on-site visit. Degree programs are encouraged to participate in international assessments or accreditations. Through all these efforts, degree programs will produce a Self-evaluation Summary Report of Degree-Granting Program along with results from the peer-review process.

On the other hand, top-down inspection usually involves the sampling of about 30% of the total degree-granting programs. Doctoral-level inspection is organized by the Degrees Committee of the State Council, which commissions the task of inspection to the Disciplinary Evaluation Group of the Degrees Committee and the National Professional Degree Graduate Education Committee. Master-level inspection is designated to provincial-level offices of the Degree Committee. The group of external experts will be responsible for peer-review process. The peer-review will be conducted based on materials provided by the degree-granting programs. Such documents or materials can include but is not limited to a Self-evaluation Summary Report of Degree-Granting Program, an Annual Quality Report of Graduate Education of the Program, and an Annual Development Report of Degree-Granting Program. Additional materials include the training plan of graduate education over the past five years, the results from the peer-review process and other documents as required by the expert group. Inspection results will be used to inform the administrative departments in their monitoring of the progress of initiatives such as the Double World-Class Project, and other important decision-making processes, such as deciding on the enrollment scale of a particular institution.

4.4 Autonomy in Setting up Degree Programs

Among all the degree-granting institutions, some institutions were approved to set up their own degree programs autonomously. So far, there are 31 universities that have been granted the authority to set up and adjust their own degree programs. According to the official document—*Guidelines on the Self-Auditing of Degree-Granting Process among Higher Education Institutions*—issued by the Degrees Committee of the State Council (The Degrees Committee of the State Council, 2018), such autonomy was given to institutions to improve the agency of institutions, enhance the quality of academic research and that of teaching and learning, and encourage institutions to develop their own strengths in their unique disciplines and some cross-disciplinary fields. These approved universities will need to set up the construction and development plan as related to the distribution of disciplines and/or cross-disciplinary fields in considering the developmental plan of their universities. The universities will clarify the developmental goals and distributions of these (cross-) disciplines. Meanwhile, strategic tasks along different phases or stages will need to be specified along with the policy measures or infrastructure that will be in place to ensure such development. These strategic plans will need to be made public and be reported to the Degrees Committee of the State Council.

It should be noted that the set-up of new-degree programs often reflects the strength of a particular university or the strategic needs of the nation or local city. The standards for setting up new degree-granting programs within these universities shall be higher than the basic requirement for similar programs in the nation. For example, in the year of 2020–2021, Tsinghua University re-arranged the distribution of degree-granting programs by adding master's-degree and doctoral-degree granting programs in integrated circuit science and engineering to reflect their strength in cross-disciplinary research and education in this area. Meanwhile, THU eliminated the master-degree programs in geodesy and surveying engineering. Peking University (PKU) added an interdisciplinary degree program in artificial intelligence (AI) building upon its accumulation of academic research in this field (The Degrees Committee of the State Council, 2021). Also, in the year of 2021, Shanghai Jiao Tong University (SJTU) approved the Master of Education degree (SJTU, 2022). This measure was taken to reflect the needs in Shanghai for more high-quality professional educators in high schools.

The measures on universities' self-auditing along with the regulations on the evaluation of the degree-granting programs together form the foundation for merit-based dynamic adjustment of degree-granting programs across the nation to encourage continual improvement of graduate education.

4.5 "Application-Review" Procedure for Recruiting Doctoral Students

In the progress of gradually improving graduate education, some important measures were also learned from current best practices and localized to the Chinese system. One of such examples concerns the procedures on recruiting doctoral students. Unified examination has been used for about two decades before Peking University first pioneered a procedure of "Application-Review" for doctorate students' recruitment in 2003 (Sheng, 2003). This procedure mirrors the common practices in other graduate education systems such the U.S. and U.K., in which prospective students apply to degree programs and submit a list of required documents to support their application (Golde & Walker, 2006; Park, 2005). Through the review processes organized by the university and the program, a committee provides a final decision based on the review of the application materials. After the pioneering effort of Peking University, more and more universities and their degree programs have made efforts to use similar practices for recruiting prospective doctoral students. By 2020, more than 90% of the "Double World-Class" universities adopted this practice for recruiting doctoral students (China Education Online, 2021).

At the master's degree level, although there is still a nationwide examination for prospective students, more and more students are recruited via a similar "Application-Review" procedure in which incoming students who rank among the top percentiles of their original programs will receive a qualification of "recommendation for admission" and then send applications to target programs. MOE has issued official documents to guide the determination of the percentages of students who can get such qualification of "recommendation for admission". According to the *Methods on Recommending Excellent Graduating Senior Undergraduate Students for Master's Degrees without Examination (Trial)* (MOE, 2006a), the percentages of students who receive this recommendation depend on the types of institutions. For example, universities with existing graduate schools usually can recommend the top 15% of their graduating seniors for admission without examination. In conclusion, recruitment practices such as the listed one, although first "borrowed" from existing systems, they developed some different characteristics as they were adjusted to the Chinese graduate education system.

5 Inspiring Stories

5.1 Tsinghua Shenzhen International Graduate School: Facilitating the Growth and Innovation of China's Silicon Valley

With the facilitation of the reform and opening-up policy in 1978, Shenzhen, the former small Barren Hamlet with only 20,000 residents, has now become one of the most dynamic developing cities in the world. Known as China' Silicon Valley, Shenzhen has also grown into a regional financial center and a global technological innovation center, with headquarters for major Chinese companies like Tencent and Huawei.

What is the secret of Shenzhen's dramatic growth? Apart from China's reform and opening-up, the establishment of Shenzhen Special Economic Zone and its location, the support of graduate education could be one of the many reasons that has facilitated Shenzhen's economic and technological development.

By the end of the twentieth century, the key to national power has altered into a competition of science and technology and a skilled workforce. Knowledge and workforce talent have become the most critical resources for city development as well. For Shenzhen, although the city construction has passed the first stage which is characterized by labor-intensive development supported by opening-up and institutional reforms, it encountered a bottleneck in its next stage of development which required human capital and high-tech support.

In 1998, there were approximately 11,000 full-time university students in Shenzhen. Among them, only 60 were master's students, and none of them were doctoral students. These rates were incompatible with Shenzhen's economic status and did not provide a foundation for meeting the future goal of being in the highest echelon of the global industrial value chain. To solve the problem, instead of creating its own universities from the scratch, Shenzhen government decided to collaborate with prestigious universities in China and establish branch universities in Shenzhen. Launched in 2001, Tsinghua Graduate School at Shenzhen (GSST), which has now become Tsinghua Shenzhen International Graduate School (SIGS), was one of the earliest and most successful models, which aimed at producing high-level talents for Shenzhen and solving major regional and global problems in science and technology and social development.

The collaboration between Shenzhen government and graduate institutions had an immediate and profound impact on both the development of Shenzhen's economic and social development and the growth of graduate institutions themselves.

On the one hand, due to the reform and opening-up policy, Shenzhen has relatively flexible policies and an active social environment. Higher education reforms were allowed and more easily explored and implemented in this environment. So as for Tsinghua University, Shenzhen has provided an experimental field to explore new models of graduate education, academic research, and higher education administrative systems. Secondly, due to the physical proximity and interpersonal ties with Hong Kong, Shenzhen also provided a window of collaboration for Tsinghua GSST, which indirectly led to the strategic integration of Tsinghua GSST and Tsinghua-Berkeley Shenzhen Institute (TBSI), which ultimately became Tsinghua SIGS in 2019. As a global technological innovation center, Shenzhen has provided numerous unique opportunities for university-industry collaboration and facilitates the commercialization of latest scientific and research findings in the academic research of Tsinghua GSST.

On the other hand, graduate institutions in return offer key resources to support Shenzhen's city construction and innovation ecosystem. First, Tsinghua GSST supported the economic and social development of Shenzhen by producing high-quality talents. In 2003, Tsinghua GSST awarded the first batch of master's students in Shenzhen. In 2004, Tsinghua GSST graduated the first doctoral student in Shenzhen. After two decades of development, it has produced 12,000 graduates and one-third of them decided to stay in Shenzhen. Currently, there are more than 4,600 graduate students in school, among which 700 are doctoral students. To support the graduate education of high-quality students, Tsinghua GSST has attracted a group of excellent faculty members from around the world. Among the more than 200 faculty members, half have received Shenzhen's various high-level talents' titles and over 30 have received national and provincial level talents' awards. It is expected that by 2025, there will be 250 faculty members in total with 1/5 of them being international faculty.

Second, Tsinghua has facilitated the transformation and updated Shenzhen's industry by the development of (inter-/cross-) disciplinary and frontier academic research. Tsinghua GSST has been very strategic in the planning of research fields since its establishment, targeting the frontiers of the field while tying closely to the needs of Shenzhen. Particularly, throughout the strategic planning of Tsinghua GSST's academic research, talent development and its service to Shenzhen, the key feature lies in their focus on inter-disciplinary and cross-disciplinary development. Depending on the rich resources of Tsinghua University, the Tsinghua GSST attempts to explore an independent developmental model. By focusing on unique disciplines and the key characteristics of existing disciplines, Tsinghua GSST has emphasized inter-disciplinary and cross-disciplinary collaboration, producing a number of unique disciplines compared to the Tsinghua main campus in Beijing.

In Tsinghua GSST/Tsinghua SIGS, these unique disciplines reflect both the local needs in Shenzhen and the strength of Tsinghua faculty. Based on these unique fields, Tsinghua GSST/Tsinghua SIGS formed a selected array of departments and research centers that are very different from their main campus, such as Department of Advanced Manufacturing, Department of Logistics and Transportation, Department of Information Science and Technology, Tsinghua Research Center on Hong Kong and Macau, Research Institute on Biomedicine and Health Engineering, Research Institute on Marine Engineering, Research Institute on Innovative Management, and Research Institute on Future Human Habitats (Tsinghua SIGS, n.d.). During the 13th Five-Year Plan (2016–2020) alone, Tsinghua SIGS had launched eight National Key R&D projects, six provincial level key R&D projects, established one National Key Laboratory, five provincial level engineering and technological centers, one Sino-Germany joint innovation center, two Shenzhen Nobel-prize scientists' laboratories, and many other municipal innovation platforms. These efforts target the critical research problems both at the national-level and at the municipal level.

The development and output of these departments and research institutes/centers have played a key and active role not only in promoting the development of Shenzhen's strategically important fields, such as information science, biopharmaceutical and health engineering, and city construction, but also in offering excellent platforms for graduate students' training by international collaboration and industrial-university cooperation. For example, a graduate student group from Tsinghua SIGS won the 40th World Architecture Community Awards in April 2022 with their project, "Super-Hydro-City!", which was designed to combat rising sea levels and provide a future solution city construction for Shenzhen Bay (Tsinghua SIGS, 2022a, b). The project was a part of a graduate-level course hosted in the Research Institute on Future Human Habitats, where leading professors from around the globe collaborated to jointly delivered the course (World Architecture Community, 2022). Also, the close connections with the industry have provided students with unique platforms to accomplish their dreams. Another recent example, Xingchen Song, a master's student in computer technology, with a dream of "seeing the sound" that was inspired by his own difficult experiences with hearing loss caused by a disease from youth, has pursued a research interest in automatic speech recognition. Thanks to the close collaboration between local tech companies and Tsinghua SIGS, in a required practicum course in the professional graduate degree program, he was able to engage in real-world projects and successfully developed milestone tools for automatic speech recognition systems, which have so far been applied in over 100 companies. In his own words, such experiences allowed him to "take one big step closer to future goals and dream…seeing the sound, I have made it" (Lin, 2022).

In addition to Tsinghua SIGS, several other graduate schools were also attracted to such a win–win developmental model for graduate institutions and local city. For example, Peking University Shenzhen Graduate School and Harbin Institute of Technology (HIT)-Shenzhen Graduate School (later became HIT, Shenzhen, having both undergraduate and graduate education) were also established in 2001. With different strengths in research fields and varied styles in graduate education, these institutions have each supported the swift development of Shenzhen's knowledge economy and technological development in various ways.

5.2 *University of the Chinese Academy of Sciences: Progressing Along with National Strategic Development*

Under the direct leadership of the Chinese Academy of Science (CAS), the University of the Chinese Academy of Sciences (UCAS) is a public university that primarily focuses on graduate-level education (ScienceNet, 2015). It originated from the pioneering graduate educational practice of CAS which took place right after the founding of the People's Republic of China. In 1950, CAS launched the graduate researchers' recruitment and development. In 1951, CAS and MOE issued an official document to recruit graduate researchers and graduate students. These were some of the earliest explorations of graduate education practices in China. In 1951, the national enrollment of graduate students was 276, among which 95 were recruited by the CAS. To further facilitate the growth of scientific talents, CAS decided to organize graduate education in a more systematic way. In 1954, CAS's executive meeting passed the *Temporary Regulations for Chinese Academy of Sciences' Graduate Students*. The document was examined and officially issued by the State Council of China the same year. This file signified the official establishment of a standard graduate education procedure within CAS. From 1955 to 1965, CAS recruited 1,517 graduate students, accounting for ten percent of the number of recruitments in the whole nation. In 1965, the number of in-school graduate students accounted for a quarter of all graduate students in the nation. The educational goal at the time was to develop graduate students that can "conduct scientific research in an independent, professional, and creative manner". Many of the early graduates have taken up critical roles in the scientific research and technological advancement in China. Evidently, CAS played an essential role for educating future scientists at the time.

China's graduate education was forced to stop completely during 1966 to 1976. In 1977, CAS restored its graduate education through efforts to facilitate the issue of the *Notice on Recruiting Graduate Students in Higher Education Institutions in 1977*, which was officially sent out by CAS and MOE, commissioning University of Science and Technology of China (USTC) to establish a graduate school in Beijing to recruit graduate students on behalf of CAS (ScienceNet, 2015). The issue of this document also symbolized the overall restoration of graduate education in China. In 1978 the Graduate School of USTC was founded as the first graduate school in China. CAS again played a critical role in its pioneering effort in restarting graduate education. After the document of *Degree Regulations of China* was issued in 1980, then the Director of CAS – Yi Fang-was appointed to be the first director of the Degrees Committee of the State Council. Moreover, among the first group of eighteen doctoral degree recipients with their degrees awarded in 1983, six of them received degrees from the Graduate School of USTC (Beijing). (It should be noted that the Graduate School of USTC [Heifei] was founded in 1986, which recruits graduate students for USTC].

In 2000, building upon the efforts of the Graduate School of the USTC(Beijing) and the graduate educational practices that were taking place in the 109 institutes across the nation leading by CAS, CAS established the Graduate School of CAS. In

2012, the Graduate School of CAS was renamed as the UCAS. The establishment of UCAS carried with it the long history of CAS's experiences in graduate education (UCAS, n.d.).

At present, UCAS, backed by 116 CAS research institutes all over the country, 306 high-level laboratories and nearly 12,900 academics (including 239 members of CAS and 40 members of the Chinese Academy of Engineering), provides an excellent platform for graduate education (UCAS, n.d.). Leading scientists are closely involved in course teaching, scientific training, and guiding graduate students' dissertations. Meanwhile, the excellent research platforms provided by more than 100 institutes have allowed top-class research environment for graduate students' research practices. Also, due to its unique relationship with CAS, UCAS adopted a "two-phase" training system, in which students first learned fundamental courses and skills in the UCAS and then joined CAS research institutes for later research work under the guidance of graduate mentors, completing their dissertations in the research institutes. This graduate education model features a deep blending of scientific research and teaching and learning (UCAS, n.d.).

Looking back, UCAS has carried out many "first-time experiences" in Chinese graduate education. It graduated China's first doctoral student in science, first doctoral student in engineering, first female doctoral student, and first student with double doctoral degrees. In the past 60 years, UCAS has in total produced more than 195,000 graduate students, including both doctoral level and master level (UCAS, n.d.). In 2014, UCAS began recruiting students at the bachelor's level as well. Since 1964, among the graduates of UCAS, 161 have been elected as members of CAS. Among the recipients of the National Science Fund for Distinguished Young Scholars, one quarter of them graduated from UCAS.

Historically UCAS's higher education focus has been on cultivating graduate students, many of whom have contributed to various strategic fields of the national development. Among one of the many examples, Nan Rendong was the former Chief Scientist, Chief Engineer of the Five-hundred-meter Aperture Spherical Radio Telescope (FAST), which is the largest and most sensitive single-aperture radio telescope. He was a UCAS alumnus who enrolled in 1978. Exploring the mystery of the universe had been Nan's career pursuit. To design and implement this arduous project, which involves knowledge and skills from multiple fields including astronomy, mechanics, mechanical engineering and geotechnical engineering, he conducted innovative work while exploring the unknown territory. He kept learning, mastering the key processes in the engineering project via the accumulation of knowledge in mechanics, measurement and control, hydrology, geology. In 2016, FAST was successfully built and put into function, which greatly helped astronomical exploration of Chinese scientists. However, he passed away in 2017, spending the last 22 years of his life working tirelessly and finally accomplished this enormous project. He once wrote down a poem, "All senses feel peaceful, every sound quite down. The marvelous universe, in its mystery and beauty, is calling us to overcome mediocrity, entering its limitless expanse…" (Liang, 2019). It is inspiring to witness such a great life and his work and how his work has contributed to a marvelous scientific advance for the nation and beyond.

Nowadays, the education of UCAS has been keeping pace with national strategic needs. For example, to solve the bottleneck problems of integrated circuit and semiconductor technological deficiency and the lack of domestic talents in such fields, UCAS launched the "one student one chip" plan (Luo, 2021). The plan includes students in the design and development of integrated circuits. As semiconductor chips are at the crux of the technology competition among countries and chip production is a priority in China's Five-Year Plans, such a plan will undoubtedly narrow the gap in semiconductor talents in the near future.

6 Latest Research

6.1 Overview of the Chinese Graduate Education Research

With the fast expansion of graduate education in China, scholarly research has also taken up momentum. On the one hand, the quick growth of Chinese graduate education has provided an excellent field for educational research exploration. On the other hand, the scholarly exploration on these expanded educational practices have offered evidence-based support for continual improvement of Chinese graduate education.

To synthesize the main themes and trends based on the Mandarin literature on Chinese graduate education, analysis in this chapter uses the full-text database of Chinese journals—CNKI, as the database to analyze the literature. "Graduate education" was used as the keyword. The time duration for the literature analyses is set from January 1, 2011 to December 31, 2021. The search results are further refined to include only the core journals focusing on higher education. Only journals that are indexed in the CSSCI are included. A total of 4,123 articles are retrieved manually by filtering out articles that do not meet the requirements or were repeatedly published. Based on the retrieved literature, this section provides an overview of the current Chinese literature on graduate education, followed by an introduction of the main themes and key trends of research in graduate education among the Mandarin literature over the past 10 years.

In terms of the publication venues, the statistics of journals that showed a focus on graduate education are summarized in Table 3. According to the statistical results, some journals show trends to publish more research on graduate education than others. Articles on graduate education are found primarily in five main journals including, "Academic Degree & Graduate Education" (1,479), "Journal of Graduate Education" (589), "Research on Chinese Higher Education" (138), "Higher Education Exploration" (68), "Journal of Higher Education" (65). In particular, the journal of "Academic Degree & Graduate Education" produced 1,479 articles, accounting for 35.9% of the total number of articles. The number of publications of Journal of Graduate Education ranked second, with the total number of 589 accounting for 14.3%. Both journals are academic journals with great influence in the field of graduate education. They each focus on important theoretical issues, major practical

Table 3 Top five journals that publish most research on graduate education

No	Journal	Publication
1	Academic degree and graduate education	1,479
2	Journal of graduate education	589
3	Research on Chinese higher education	138
4	Higher education exploration	68
5	Journal of higher education	65

Source Compiled from search results from CNKI

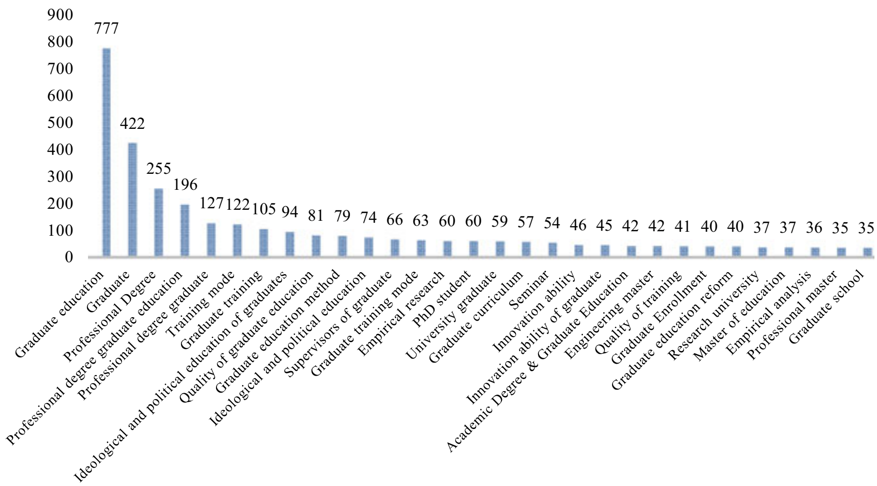


Fig. 21 Top 30 keywords in graduate education literature. *Source* Compiled from search results from CNKI

challenges, and the latest trends in graduate education, with the aim of exploring innovative ways to advance graduate education.

Concerning the research topics of graduate education, an analysis of keywords of the 4,243 retrieved articles was conducted. The top 30 keywords and their corresponding frequency counts are shown in Fig. 21. A thematic grouping of these keywords leads to four main themes that will be discussed in the following section. The themes can help the understanding of the development trends and research hotspots in graduate education.

6.2 Main Themes and Key Trends

The main themes highlight the key points and core trends of the topics of these research articles. The research themes related to graduate education in the past 10 years can be summarized into the following four aspects.

6.2.1 Educational Models and Modes of Graduate Students

The keywords involved in this topic include educational models and modes, graduate students' training, training models/modes of graduate students, methods for graduate education, graduate students' curriculum, graduate education reform and so on. Educational models/modes refer to teaching and learning methods, a series of carefully designed graduate student courses or curricular system, or a series of well-thought-out training courses/learning activities/programs in the graduate educational practices. More specifically, the research on the educational models/modes of graduate students involves multiple research content, including the exploration, construction, and reformation of these educational models for the purpose of identifying a more reasonable graduate educational model. This line of research remains closer to the scholarship of application, often introducing a particular model that has been implemented at a particular institution or degree-granting program. With the pros and cons offered by practitioners summarized from their practical experiences of implementation, providing lessons-learned for other practitioners. Some of the research might use surveys or interviews to collect empirical data. However, the survey tools used in some research might require further validation, in that evidence-based research of the actual implementation of the educational models might be in need for further exploration. Still many others were position papers, summarizing the challenges and opportunities in particular educational models based upon reflections of practitioners' experiences instead of evidence-based data. Only a small portion of research conducted in this line utilized well-tested survey instruments or well-designed interview protocols to explore the outcomes of the educational models under investigation. Despite the small number, these studies reflect the effectiveness of some unique training models for graduate students (Chen & Dong, 2009; Zhou et al., 2015), demonstrating some of the promising outcomes of graduate educational reform (Huang & Yi, 2014; Li, 2005). It should be noted here that the trend of relying on reflections of practitioners with more position papers than evidence-based research unfortunately has been a general trend across all four themes. This trend, although having started to change, remains to be common in Chinese higher educational research (Yuan & Huang, 2022).

6.2.2 Professional Degree Graduate Education

The keywords involved in this topic include professional degree, professional degree graduate education, professional degree graduate students, Master of Engineering, and professional masters. The themes on professional degree graduate education mainly included research on introducing international best practices, domestic best practices, or research on educational practices. Additional research also explored educational models for professional degree graduate education. Chinese graduate education has witnessed an increasing interest for professional degree graduate education. Professional degree education has become an essential part of Chinese graduate education, picking up in both quantity and quality. Despite a large portion of journal articles being position papers, these reflection-based articles pointed to some common problems in professional degree education. First, the training of professional degree graduate students showed limited difference from that of academic degree graduate students (Hu, 2006). This phenomenon can be problematic because the two models are designed towards producing different types of professionals, one being research-oriented and the other being application-oriented (Wen et al., 2010). Other related problems are the lack of practical learning experiences for professional degree graduate students. Moreover, the collaboration between university and industry needs to be strengthened for professional graduate education. Also, the assessment of graduate students pursuing professional degrees versus academic degree requires different criteria which have yet to be clearly defined. Combined with the basic characteristics of professional degree graduate students, exploring their appropriate training modes and assessment should require greater attention from researchers (Huang, 2010).

6.2.3 Quality Assurance System of Graduate Education

The establishment and improvement of a holistic quality assurance system for graduate education is the key to improving the quality of graduates and ensuring the high-quality development of graduate education. The establishment of a holistic quality assurance system has always been the core task of graduate education and aroused continuous attention of scholars over the past decade. The keywords involved in this topic include the quality of graduate education and the quality of training. More specifically, research that involves quality assurance relates to topics such as the establishment of internal quality assurance system, various concrete measures that have been taken to ensure quality in graduate education, and the effectiveness of such measures or systems (Wang, 2015; Wang & Li, 2012). Journal articles that summarize prior experiences and best practices in setting up quality assurance systems within an institution or a degree-program revealed some common practices in Chinese graduate education. Some of the practices include measures such as, the double-blinded review of theses and dissertations, evaluations of course teaching through student reports and external seasoned instructors' field observations, standardizing the types and procedures in organizing milestone exams for graduate students (e.g., Qualifying exams and preliminary exams), and standardizing the procedures in organizing the recruitment process of new graduate students to ensure equality, fairness and public accountability (Liao et al., 2012; Rong & Deng, 2018; Zhao & Zhou, 2011).

6.2.4 Graduate Supervisors' Skill Development

The keyword involved in this topic is graduate supervisors. Supervisors play an extremely important role in the process of graduate training. As stated in national policies, graduate supervisors are regarded as the first responsible person for graduate students' education. Therefore, developing a large group of qualified supervisors can directly affect the quality of graduate training and how to develop a group of high-quality supervisors for graduates has attracted more and more attention among the researchers. Some research, especially research on educational administration, covers topics such as the selection, management, supervision, and evaluation of graduate mentors (Pan & Gu, 2022; Wang, 2005). Additional researchers pay attention to the relationship between mentors and graduate students, studying topics such as graduate students' satisfactory levels with the mentoring and the impacting factors (Zhou et al., 2010). Still other literature covers topics on graduate supervisors' professional development, in particular the challenges they may encounter and the possible ways they might navigate to succeed in their careers (Bao & Yang, 2021; Zhao & Feng, 2021). Such literature reveals trends in the common problems faced by graduate mentors in Chinese graduate education. These problems include the need to balance research and teaching, the lack of proper training in pedagogical skills, and the need for training to perform their duties of mentoring students especially for different types of students (professional versus academic ones) (Xue et al., 2022).

6.2.5 Additional Research Themes

Besides these four main themes, there are a couple additional themes that also attract scholars' attention, one of them being the ideological and political education of graduate students. In recent years, promoting the construction of "course-based ideological and political education" comprehensively has become an important topic encouraged by quite a few national policies. Research in this area often discusses ways to infuse ideological and political education into professional courses. Another theme was about the cultivation of innovation ability for graduate students. Graduate education is regarded as one of the key platforms for developing high-level innovative talents. Therefore, cultivating graduate students' innovative ability has long been a hot topic in Chinese graduate education. Research hotspots on the cultivation of graduate students' innovation ability mainly involve the training mode or mechanism related to developing innovation ability among graduate students, the curriculum system and teaching methods, the training environment, and the differences in the cultivation of innovation ability among different types of graduate students.

Overall, the recent trends in the research of Chinese graduate education reveal some existing challenges for graduate students' training and the professional development of graduate mentors. Challenges are also presented in terms of the education of professional degree graduate students. Current research mainly conducted based upon practitioners' reflections has offered some valuable suggestions to solve some of these problems. Nevertheless, to provide more practical suggestions, more evidence-based educational research is yet to be conducted to investigate the actual causes of such challenges or problems.

7 National Policies

7.1 Foundational Policies

Over the past four decades, the strong national policies and relevant measures provided by the Chinese government have rendered great support for the development of graduate education in China. Shortly after the commission of the Graduate School of USTC by CAS, the issue of Degree Regulations of the People's Republic of China in 1980 set the foundation for later policies in graduate education (National People's Congress, 2004). Chinese graduate education was then set on a path of gradual progress after 1977. The Degrees Committee of the State Council (later became a joint office with the Department of Degree Management and Graduate Education, MOE) is responsible for the strategic reform and planning of the national graduate education and the administration of graduate educational practices. The continual efforts of the administrative office in guiding the national development of graduate education have allowed a steady progress of Chinese graduate education in terms of the setup and evaluation of degree-granting institutions or programs, reform and continual improvement in graduate education, international collaboration with foreign institutions in graduate education and many other works related to graduate education.

7.2 Recent Key Policies

In 2013, a key policy document was officially proposed after the Eighteenth National Congress of the Communist Party of China (2012), that is, the *Guidelines on Deepening Graduate Education Reform* (MOE et al., 2013). This document points out that the Chinese graduate education had entered a new developmental era. The strategic roles of graduate education in promoting innovation-driven development and increasing global competitiveness have been emphasized in many countries. Therefore, it is imperative to conduct comprehensive reformation in Chinese graduate education, to produce high-quality talent that can support innovation at the national level. The two key measures are coined, one being the reformation of educational models according to different categories of degrees, another being the establishment of quality assurance system for graduate education. Many of the recently proposed policies are closely related to this key document. Here, this chapter summarizes the main three lines of policies that in a sense highlight some of the key characteristics of Chinese graduate education.

7.2.1 Quality-Centered Intensive Development

Quality of graduate education has been the focus of a series of national policies. A number of key regulations and documents were issued to offer guiding principles for various aspects of graduate educational practices. As mentioned in the previous best practice section, these documents emphasize quality assurances by engaging multiple stakeholders in the process and stressing the agency of institutions. Institutional agencies are partly demonstrated in the process of setting up degree programs autonomously for some institutions. Additional measures that ensure quality control include the random inspection of master's and doctoral theses and the regular evaluation of degree-granting programs. In addition, some measures are proposed to place strong emphasis on the importance of the mentoring relationships between faculty members and graduate students, recognizing "the supervisor being the first responsible person for graduate students' education" (MOE, 2018a).

The overall of national policy that focuses on quality assurance in graduate education includes a series of documents; one of the most important ones being *Guidelines on Strengthening the Degree and Graduate Education Quality Assurance and Monitoring System* (The Degrees Committee of the State Council & MOE, 2014a). Establishing a quality assurance and monitoring system involves efforts in various aspects. Therefore, a number of other documents were issued along with this document. Specific policies that are related to various measures to implement the core ideas in this document include policies in the following different areas.

First, in terms of the evaluation of degree-granting programs, there are several related measures, for example, *Measures to Evaluate the Degree-Granting Programs* (The Degrees Committee of the State Council & MOE, 2014c), and *Methods for the Dynamic Adjustment of Doctoral, Master's Degree-Granting Discipline and Professional Degree Granting Categories* (The Degrees Committee of the State Council, 2015). These documents delineate specific procedures, standards, and essential documentations for evaluating degree-granting programs in institutions. In addition, the Degrees Committee of the State Council regularly announces lists of degree-granting programs that have been terminated or added after the evaluation and the dynamic adjustment. Second, as related to the quality control of graduate dissertations, the main document has been the *Measures to Inspect Master's and Doctoral Deposited Theses through Random Sampling* (The Degrees Committee of the State Council & MOE, 2014b). The document provides guidelines for implementing blind-review procedures for theses across the various institutional types. Third, as for the autonomy in setting up degree programs, main policies that cover relevant materials include *Methods to Audit the Granting of Doctoral and Masters' Degree* (The Degrees Committee of the State Council, 2017), and *Guidelines on the Self-Auditing of Degree-Granting Process among Higher Education Institutions* (The Degrees Committee of the State Council, 2018). These documents offer basic requirements about new degree-granting programs and auditing procedures to guide institutions in their practices. Fourth, for the assessment and evaluation of graduate advisors, quite a few new policies were proposed concerning this area, including *Guidelines on Accomplishing Graduate Supervisors' Roles and Responsibilities in*

Cultivating Virtues and Developing Talents (MOE, 2018a), and *Graduate Supervisor's Mentoring Behavioral Guideline* (MOE, 2020c). These documents not only list the general responsibilities of mentors, but also provide guidelines about graduate advisors' promotion and evaluation. Finally, for the "Application-Review" procedure for recruiting doctoral students, the main policy document was *Methods on Recommending Excellent Graduating Senior Undergraduate Students for Master's Degrees without Examination (Trial)* (MOE, 2006a). Although it was proposed before the 2013 document on deepening the graduate education reform, the practice of "Application-Review" procedure has gone through continual refinement and wider adoption after the 2013 document, proving itself an important measure for ensuring the quality of recruitment of graduate students. These policy documents and measures focus on different aspects of graduate education, together aiming at constructing a system of quality assurance for Chinese graduate education.

It should be noted that many of these measures mirror some of the accountability check measures of the ones that are implemented in the existing graduate education systems such as in the U.S. institutions or programs (Council for Higher Education Accreditation [CHEA], n.d.) and in the U.K. system (Quality Assurance Agency [QAA], n.d.). For example, in the external quality review process in the US, peer reviews are often based on solid evidence such as written reports, site visits and interviews conducted by external experts (CHEA, n.d.). Meanwhile, the internal quality review process can include student evaluation, review of faculty performance (such as tenure and promotion reviews), and other types of internal quality control measures. However, there are also noticeable differences between the Chinese graduate education system and the ones found in the existing developed countries. For example, the external peer reviews for U.S. institutions are often conducted by non-profit organizations, while in the case of Chinese graduate education, the MOE has played the leading role in this process. Together, the implementation of many of these polices and measures, while echoing some of the measures in existing graduate educational systems of developed countries such as the U.S., still demonstrates features that are unique to the context of Chinese graduate education.

7.2.2 Innovations on the Training Process

Considering the ever-increasing complicated demands for the skills and attributes towards graduate students, another key line of national policies and measures focuses on encouraging innovations on the students' training process. In the *Guidelines on Deepening Graduate Education Reform* (MOE et al., 2013), one of the two key measures was to reform educational models according to different categories of degrees. Such innovations on graduate education target the development of different types of degree students to respond to the various needs and demands of technological, social, and economic development of current society. To meet these needs, this line of policies and measures focused on education innovations such as initiating professional degree programs, experimenting dual-mentor structure for graduate education, diversifying the career developmental paths of doctoral students, and emphasizing cross-disciplinary skill development for students.

First, in terms of setting up professional degree programs, in 1990, the Degrees Committee of the State Council passed two documents: *Reports on Investigations to Setting up Professional Degrees*, and *Several Guidelines on Setting up and Piloting MBA Degree Education.* In 1991, nine universities were approved to pilot MBA degree education, signifying the beginning of professional graduate degree education in China. Later, series of national polices were issued to improve the educational process, including, *Several Guidelines on Strengthen and Improving Professional Degree Education*, *Overall Developmental Plan for Master's and Doctoral Professional Graduate Degree Programs*, and *Methods for Setting up and Auditing Professional Master's and Doctoral Degree Programs.* More recent documents include *Developmental Plan for Professional Graduate Degree Programs (2020–2025)* (The Degrees Committee of the State Council & MOE, 2020b). This document points out that by 2025, China will increase the scale of professional master's degree students' enrollment to 2/3 of all master's students. Also, the number of professional doctoral degree students' enrollment will be greatly increased.

Second, to promote educational innovation in the training process, MOE proposed documents such as *Notice on Implementing Comprehensive Reformative Piloting Projects for Doctoral Education* to encourage institutions to apply for pilot projects meeting the listed guidelines in the document (MOE, 2019c). The guidelines that were related to innovations in the training process include strengthening graduate students' professional development, improving graduate mentors' academic ability and practical experiences, exploring the engagement of industrial representatives in graduate mentoring, increasing graduate students' international experiences for scholarly communications and other aspects. Within the proposed projects, institutions can draft their own goals according to their own strengths in graduate education. The pilot institutions will submit documents to MOE regularly to report on the progress of the projects. The official website of MOE made open some of best practices emerging in the pilot efforts across different institutions. Additional related documents include, the *Temporary Methods for the Joint Development of Doctoral Students between Higher Education Institutions and Research Institutes* (MOE, 2009), *Guidelines on Improving and Strengthening Graduate Courses Development* (MOE, 2014). Documents like these point to the directions for further improving graduate education by optimizing the curriculum and identifying innovative practices to diversify the training process.

These policy documents and measures focus on reforming and innovating the graduate training process. Together they aim to produce graduate-level talents that can adapt to the changes of social, economic and technological development of the Chinese society. Many of the proposed measures can find counterparts in the existing graduate education systems in the developed countries. For example, the training of professional graduate students has been established and further improved in the U.K. and quite a few European countries, such as Germany and Sweden. The U.K.

has set up specialized centers for the training of professional engineering doctoral degrees. In such training centers, students are provided with opportunities to work with industrial-oriented projects along with comprehensive skill training (Association of Engineering Doctorates, n.d.). In the measures proposed in the *Overall Developmental Plan for Master's and Doctoral Professional Graduate Degree Programs* by the Degrees Committee of the State Council, emphases were also put on involving the multiple stakeholders for professional degree education (The Degrees Committee of the State Council, 2010). Representatives from the industry sectors were encouraged to participate in the training process. Moreover, professional degree programs feature different training focus than that of the academic degree programs. The target prospective students' groups are also different. Such differences in prospective student groups are further accomplished by the alternative students recruiting procedure for students who apply for the professional degree programs.

7.2.3 Strengthening International Cooperation

In response to the trend of economic globalization, measures concerning internationalization were proposed in the higher education realm to facilitate international collaboration. The third line of policies and measures focus on strengthening scholarly communications of graduate students with international peers and the collaborative training of graduate students between domestic and international higher education entities. Additional measures have also been proposed to attract international students to the Chinese graduate education system.

In terms of increasing domestic graduate students' experiences in international scholarly communications, some of the official regulations include, *Measures for the Selection Procedure of State-financed Graduate Students for Studying Abroad* (MOE, 2006b), and *Regulations for the Management of Chinese Government Overseas Graduate Students (Trial)* (MOE & Ministry of Finance, 2007). Through such measures, a number of domestic graduate students received the opportunities to be exposed to graduate education in many developed countries, such as the U.S. and the U.K.

As the competitiveness and attractiveness of Chinese graduate education increase, more and more international students choose China for their graduate studies. To ensure the educational quality of international graduate students to China, there have been also important policies and measures, such as the issuing of the *Study in China Plan* by MOE (2010a). The plan solidifies the existing structure for attracting international students by delineating a series of guidelines covering areas such as the recruitment, scholarship, administration, curriculum, and many other aspects as related to international students' study in China. Additional measures regulate the procedures for foreign students' application of state scholarships. Recently, another important document—the *Quality Standards on the Higher Education of International Students in China (Trial)* was issued by MOE (2018b). This document set the standards for international students' education in China. It covers various areas in higher education including graduate education, such as the creation of majors that accept international students, the degree-granting process, student management, and other aspects in higher education.

To facilitate scholarly communications and increase the share of excellent educational resources, joint programs and branch campuses of international leading university in China have been increasing over the past several decades. Meanwhile, some Chinese universities have grasped the opportunities to establish overseas campus for graduate education. For example, the SJTU-Asia–Pacific Graduate Institute was established in 2019 in Singapore. *Implementation Measures for the Regulations of the People's Republic of China on Chinese-foreign Cooperation in Running Schools* has been one of the important policies to give support and guidance. The topic of international education will be further discussed in Chap. 11 of this book.

8 Summary

In conclusion, Chinese graduate education has experienced a rapid growth in both quantity and quality in comparison to the data from the current leading graduate education systems. The national-level policies have played an irreplaceable role in guiding the direction of Chinese graduate education development. Meanwhile, the arduous piloting and experimentation of leading universities and institutions in the graduate educational practices have contributed to a variety of educational innovations that have gradually diffused to other universities and institutions in the nation. Through a continual devotion to improve the overall quality, learning both from the leading existing graduate education systems and from the local trials and errors at various levels (course-level, departmental-level, and university-level), Chinese graduate education has developed unique characteristics that reflect the needs of its social and economic environment.

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Chapter 7
Professional Education in China

Lu Chang

Abstract Professional education is essential for the needs of society and the advancement of industry. This chapter overviews the establishment, developmental process, and status of professional education in China. The first section reviews the history, development, and primary programs of studies. Then, this chapter reports key statistics of China's professional education and compares it with that of several countries in the world. Third, a framework of excellence indicators for evaluating professional education is described and interpreted, followed by three cases of best practices and two inspiring stories of Chinese professional education. Lastly, significant national policies on professional education in China are listed and examined. Follow-up longitudinal investigations should be conducted to describe and extrapolate the optimal pathway to further develop the Chinese mode of professional education.

Keywords Professional degree · Academic degree · Higher education · Graduate enrollment and graduation · Social advance and industry changes

1 Introduction

1.1 Background

In China, professional degrees are designed and established for the needs of specific occupational fields in society. Professional degrees have been developed primarily at post-secondary educational levels and can be categorized into full-time and part-time programs. In contrast with academic degrees, professional degrees aim to cultivate high-level practice-oriented professionals (Graduate Admissions Information Network [GAIN], 2022). Thus, the requirements of professional degrees differ from academic degrees. As of 2022, China has established a professional education system

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with master's degrees as the mainstay, with doctoral and bachelor's degrees coexisting. More specifically, there are 39 types of master's professional degrees, five types of professional doctoral degrees, and one bachelor's professional degree (China Academic Degrees and Graduate Education Information, 2022a).

Before 1999, few professional degree programs at the postgraduate level were offered in China. Postgraduate students were mainly trained academically for faculty or scientific researcher positions (Deng, 2019). Therefore, professional education specifically targeted incumbent workers to meet their requirements for in-service improvement (Xu, 2020). To this end, the Degrees Committee of the State Council created channels for in-service personnel to pursue professional degree education and part-time training, which greatly satisfied the needs of in-service personnel to improve their professional skills (GAIN, 2022). With the rapid development of China's economy in recent years, occupational differentiation has become increasingly fine-tuned, and new occupational types have emerged. Meanwhile, requirements for technical skills were also levelled up in the industry. Therefore, the demand for high-level professionals in the field has become more vigorous. Professional degrees not only meet the needs of existing incumbents, but also attract interest from graduating undergraduate students who wish to work in industry.

In 1991, to accelerate the training of high-level applied professionals in different areas of the domestic economy and society, the Degrees Committee of the State Council approved the establishment of professional degree programs in a few subject areas, including Master of Laws (J.M), Master of Engineering, Bachelor and Master of Architecture, Master of Public Administration (MPA), Master of Business Administration (MBA), Master of Education (M.Ed.), Master and Doctor of Medicine, Master of Agriculture, Master and Doctor of Veterinary Medicine among other professional degrees (GAIN, 2022).

Over the decade, the Ministry of Education (MOE) in China has been vigorously promoting professional degree enrollment and program development. As of 2001, professional education in China has achieved substantial progress on program development and scale of student enrollment. For example, a total of 56 universities and colleges offered MBA programs and awarded 3,026 MBA degrees, and the number of total enrolled students reached 13,890. In addition, 70 universities and colleges provided professional master's programs in engineering, with more than 5,690 enrolled students (GAIN, 2021). A total of 43 universities and colleges offered master's degrees in clinical medicine, with more than 1,678 students. Twelve universities and colleges offered master's degrees in architecture, with 200 graduates (China Academic Degrees and Graduate Education Information, 2022b). Professional degrees at the master's level have become mainstream in China. The number of professional master's degrees surpassed academic master's degrees in many programs of study. As of 2010, 509 institutions in China offer postgraduate programs, including 2,679 master-level professional degree programs and 66 doctoral-level professional degree programs; more than one million professional degree postgraduates have been recruited (MOE, 2012).

To conclude, the establishment of professional degrees is an essential part of China's higher education reform, which has changed the academic-degree-only status quo. It has promoted the cultivation of high-level applied specialized talents and enriched the types of post-secondary degree programs. After years of experimentation and development, professional education has become an essential part of degree and postgraduate education.

1.2 Categories of Professional Degree

In China, the Degrees Committee of the State Council and MOE have established several national education steering committees for different programs of study. The committee comprises governmental authorities, scholars from research institutions, and experienced professionals from relevant industry. Established steering committees include the China National MBA Education Supervisory Committee, the National JM Education Steering Committee, and the National Graduate Education Steering Committee for Professional Engineering Degree, etc. (GAIN, 2022). The committees supervise the development and management of different types of professional degree programs.

Professional degree programs can be categorized as part-time and full-time programs. The part-time programs are usually taken by mature students who work full-time. Therefore, part-time programs generally take two to four years to complete. On the other hand, a full-time professional degree program generally takes two to three years to complete. Full-time programs also require a practicum for a minimum of six months (Li & Yan, 2021).

In China, full-time postgraduate professional education usually confers dual credentials, including degree certificates and graduation certificates. The degrees certify that candidates have met the requirements for graduation; whereas the graduation certificates prove that candidates have completed all training sessions of a program (Zhang & Dong, 2018). On the other hand, part-time professional degree education only confers degree certificates but no graduation certificates. Still, there are exceptions, such as MBA, LL.M, Master and Doctor of Clinical Medicine, Bachelor and Master of Architecture.

Apart from full-time and part-time degree programs, there are also non-degree programs that offer professional training at postgraduate level, namely, “postgraduate advanced courses”. These programs provide core courses of postgraduate majors without entrance examinations or educational qualifications. Therefore, degree certificates are not conferred. However, those who have completed advanced postgraduate courses can be recognized for “equivalent academic ability” and can apply for a master’s degree by passing national examinations, completing a thesis and other program-specific requirements (Liu et al., 2022).

In terms of programs of study, there is a wide range of fields for professional degrees which focus on career development. Below are some of the most common categories of professional master’s or doctoral degrees in China and in the world.

Master of Business Administration (MBA) is designed to develop student’s skills and knowledge on business and management for their career progression in various fields. Most MBA applicants are mid-career professionals with at least two years of working experience (Abasi, 2018). Some MBA degree programs also provide training on accounting or finance given candidates' fields of interest.

Executive master's degree is designed specifically for mid-career executive professionals. In contrast with MBA candidates, executive master's degree candidates are required to have gained significant professional experience in their field of specialization (*ibid*). The most common type of executive master is Executive Master's in Business Administration (EMBA).

Master of Education (M.Ed.) programs prepare pre-service teachers for career development in education. Some Master of Education programs provide students with credentials to teach specific subjects such as math and English language in schools (Bai & Zhang, 2018); while others are designed for already certified teachers or administrative staff to specialize in areas such as curriculum design, teaching methods, counselling, and administration (Zhu, 2019). Several universities also offer Doctor of Education degrees (Wu & Yao, 2020).

Master of Public Health (MPH) programs are interdisciplinary based on medicine. Students are taught how to monitor, diagnose, and regulate the health concerns of communities through public policies (Zhang et al., 2020). Many MPH programs are specialized in areas such as epidemiology, occupational health, and nutritional sciences. Some MPH programs only accept medical students, whereas others accept applicants from other fields including statistics and nutritional sciences.

Master of Laws (also known as LL. M) programs more practical. Programs assume that candidates already have graduated with a professional law degree and want to practice in a specialized area of law. The training usually requires candidates to combine their previous work experience and knowledge gained through research to advance their career development (Yuan et al., 2021).

Master of Engineering programs can be either academic with a focus on engineering theories and practice or professional with a focus on preparing students for work in the engineering field. Compared with academic programs which prioritizes academic publications, the professional programs mandate candidates complete training periods in industry or laboratories or a combination of the two in order to graduate (Academic Degrees and Graduate Education, 2018).

Master of Architecture programs in architecture train students through practical internships and a thesis or final project. The Master of Architecture involves systemic trainings on building science, structural engineering, or architectural history. Professional practice such as building design is used to assess candidates in order to receive their license (GAIN, 2022).

Master of Fine Arts programs grant in disciplines such as the visual, performing and studio arts. This may include graphic design, photography, filmmaking, theatre, and painting. In additional to art theories, practical skills such as computer-assisted design are required for enrollment depending on different specialized fields (Zhang, 2021).

Table 1 provides a comprehensive summary of all professional degrees offered in China across bachelor's, master's, and doctoral levels. Major subject domains include education, engineering, medicine, design, and architecture.

Table 1 Professional degree programs in China

Fields of studies		
Undergraduate level		
Architecture		
Master level (from A to Z)		
Accounting	Agriculture	Antiquities and museums
Applied linguistics	Applied psychologies	Architecture
Art	Asset evaluation	Auditing
Biology and medicine	Business administration	Clinical medicine
Civil and hydraulic engineering	Dentistry	Education
Electronics and communications	Energy power engineering	Engineering management
Forestry	Finance	Journalism and communication
Insurance	International business	International education in Chinese
Landscape architecture	Law	Library and information science
Materials chemical engineering	Mechanical engineering	Military science
Nursing	Pharmacy	Physical education
Police	Public administration	Publishing
Public health	Resource and environment	Taxation
Traditional Chinese medicine	Traditional Chinese pharmacology	Translation and interpreting
Transportation	Tourism management	Social Work
Urban planning	Veterinarian	
Doctoral level (from A to Z)		
Clinical medicine	Dentistry	Education
Engineering	Traditional Chinese pharmacology	Veterinarian

Source Adapted from GAIN (2022)

In conclusion, this section introduces the definition, history, and status quo of professional education in China. More specifically, this section overviews the founding of professional degree programs, the main categories of professional programs across undergraduate, master's, and doctoral levels, and the complete list of professional degree programs in China. The following sections examine data on professional education in China and the world, excellence indicators implemented for evaluating professional degree programs, best practices of professional education in China, inspiring stories on professional education, and lastly, related national policies.

2 Highlighting Data

China initiated the implementation of professional degree education in 1990. After more than a decade of effort, professional degree education has developed rapidly and achieved remarkable success.

Several professional degree categories have achieved close connection with vocational qualifications in major industries in China such as engineering, business and management, medicine, and law. Among them, the number of professional master's degrees awarded has increased significantly in recent years, reflecting the urgent need for high-level application-oriented professionals in national economic construction and social development. In the 2008–2009 academic year, China has awarded about 489,700 professional master's degrees and about 7,000 professional doctoral degrees. As of 2019, a total of 3.21 million professional master's degrees and 48,000 doctoral degrees have been awarded, and 47 professional degree categories have been set up to meet the needs of the industry, with a total of 5,996 master's degree programs and 278 doctoral degree programs across the nation (GAIN, 2022).

China actively fosters postgraduate education for professional degrees and strengthens the cultivation of a highly skilled workforce. The number of professional masters and the number of professional master's degree recipients have both surpassed the numbers of academic master's students and degree recipients in many programs of study (MOE, 2022). In 2020, 13,719 professional degree doctoral students were newly enrolled, accounting for 11.8% of the number of newly enrolled doctoral students, with an increase of 1.90% over the previous year. Meanwhile, 602,000 professional degree master's degree students were newly enrolled, accounting for 60.80% of newly enrolled master's students, an increase of 2.40% over the previous year (MOE, 2021). Next sections detail the statistics of student enrollments and degree recipients of professional degrees in the last ten years in China.

2.1 Professional Master's Student Enrollments in China

MOE has been reporting the number of enrollments and graduates of master's and doctoral students versus the total number of master's and doctoral students since 2011 (MOE,). Tables 2 and 3 summarize annual statistics between 2011 to 2020 on the total number of master's and doctoral student enrollments, the number of academic and professional master's and doctoral student enrollments, and their proportions. Statistics show that as years passed, the total number of master's students increased from 494,609 in 2011 to 990,504 in 2020, experiencing a doubling of the number. Among all master's students, the proportion of academic master's students gradually decreased from 68% in 2011 to only 39% in 2020. In contrast, the proportion of professional masters increased greatly from 32 to 61%, also doubling the proportion in 2011. As of 2011, the number of enrolled professional masters reached 602,495, which is more than the total number of master's students in 2011. Findings reveal that although the number of master's, academic master's, and professional masters all increased over the years. Professional masters demonstrated the fastest growth speed as well as the proportion, which reflects Chinese policies on further expanding the scale of professional education. Figure 1 illustrates the trend of master's enrollments in China over the last decade. The figure shows that professional masters outnumbered academic master's students for the first time in 2016, then experienced a minor fallback between 2017 and 2019, and surpassed academic master's students again in 2020.

Table 2 Master's student enrollments in China (2011–2020)

Year	Total master's students	Female master's students	Master's students in academic programs	Master's students in professional programs
2011	494,609	256,192	336,110 (68%)	158,499 (32%)
2012	521,303	269,222	324,152 (62%)	197,151 (38%)
2013	540,919	278,288	316,060 (58%)	224,850 (42%)
2014	548,689	288,058	309,942 (57%)	238,747 (43%)
2015	570,639	304,600	308,922 (54%)	261,717 (46%)
2016	589,812	322,938	310,195 (53%)	279,617 (47%)
2017	722,225	388,556	320,121 (44%)	402,104 (56%)
2018	762,464	418,806	322,660 (42%)	439,804 (58%)
2019	811,334	446,643	474,273 (58%)	337,061 (42%)
2020	990,504	530,891	388,009 (39%)	602,495 (61%)

Source MOE (2012–2021)

Table 3 Doctoral student enrollments in China (2011–2020)

Year	Total doctoral students	Female doctoral students	Doctoral students in academic programs	Doctoral students in professional programs
2011	65,549	7,417	64,116 (98%)	1,443 (2%)
2012	68,370	25,489	66,638 (97%)	1,732 (3%)
2013	70,462	26,896	68,743 (98%)	1,719 (2%)
2014	72,634	28,380	70,619 (97%)	2,015 (3%)
2015	74,416	29,679	72,491 (97%)	1,925 (3%)
2016	77,252	31,639	74,743 (97%)	2,509 (3%)
2017	83,878	35,073	81,178 (97%)	2,700 (3%)
2018	95,502	41,012	88,718 (93%)	6,784 (7%)
2019	105,169	45,719	94,783 (90%)	10,386 (10%)
2020	116,047	49,593	102,328 (88%)	13,719 (12%)

Source MOE (2012–2021)

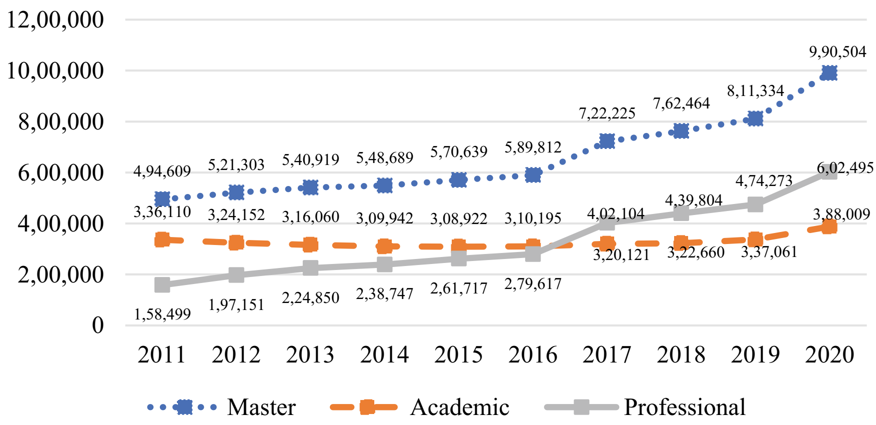

Fig. 1 Trend of master's student enrollments in China (2011–2020). *Source* MOE (2012–2021)

2.2 *Professional Doctoral Student Enrollments in China*

Table 3 displays the annual statistics on professional doctoral student enrollments in China. Generally, the scale did not demonstrate significant growth in the last decade, whereas academic doctoral students accounted for most of the total doctoral enrollments. More specifically, the total number of doctoral student enrollments increased from 65,549 in 2011 to 116,047 in 2020. Among all the doctoral students, most of them have been in academic programs during the last decade. However, the proportion of academic doctoral students gradually decreased from 98% in 2011 to 88% in 2020, experiencing a fall down of 10%. In contrast, the proportion of professional doctoral students increased greatly from only 2% to 12%, which is six times more than the proportion in 2011. As of 2011, the number of newly enrolled professional doctoral students reached 13,719. Although the proportion of professional doctoral students is still way lower than the proportion of academic doctoral students, the proportion and number of enrolled doctoral students still increased significantly over the last decade, which aligns with the national policies on professional education. Figure 2 demonstrates the trend of doctoral student enrollments in China over the previous ten years. In general, the number of professional doctoral students has been way lower than that of academic doctoral students, which can be attributed to the nature of doctoral studies. However, as time passed, the proportion of professional doctoral students over the total number of enrolled doctors gradually increased.

2.3 *Professional Master's Degree Recipients in China*

Table 4 shows the total number of master's degree recipients, the number of academic and professional master's degree recipients, and their proportions between 2011 and

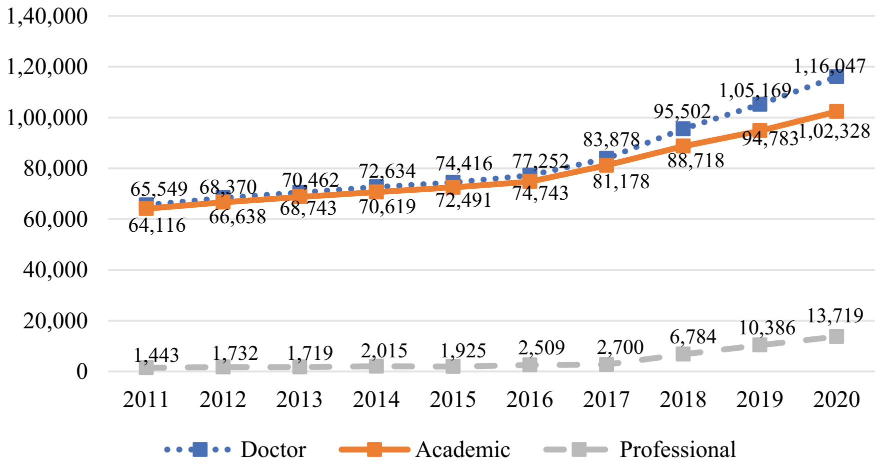

Fig. 2 Trend of doctoral student enrollments in China (2011–2020). *Source* MOE (2012–2021)

2020. Table 4 shows that over the past ten years, the total number of master's degree recipients increased from 379,705 in 2011 to 662,451 in 2020. Among all the master's students, the proportion of graduates with an academic master's degree gradually decreased from 87% in 2011 to only 44% in 2020. In contrast, the proportion of graduates with a professional master's degree increased considerably from 13 to 56%. As of 2011, the number of professional master's degree recipients reached 369,459 and the proportion is larger than 50% for the first time. Data show that degree recipients increased across all categories. Figure 3 illustrates the trend of master's degree recipients in China over the last decade. The figure shows that professional masters' degree recipients outnumbered academic master's degree recipients for the first time in 2020 and then kept growing at a faster speed (see green line's slope in Fig. 3) after that, which can be attributed to the issue of *Developmental Plan for Professional Graduate Degree Programs (2020–2025)*, this document will be detailed in the section National Policies.

2.4 Professional Doctorate Recipients in China

Table 5 displays the annual statistics of doctorate recipients in China. Similarly, with professional master's degree recipients, the total number of doctorate recipients increased from 55,618 in 2011 to 66,176 in 2020. Among all the doctoral degree recipients, most of them have been from academic programs during the last decade. However, the proportion of academic doctoral degree recipients gradually decreased from 98% in 2011 to 96% in 2020, experiencing a minor decrease. In contrast, the proportion of professional doctoral degree recipients increased from 2 to 4%. As of 2011, the number of enrolled professional doctoral students reached 66,176, only

Table 4 Master's degree recipients in China (2011–2020)

Year	Total master's degree recipients	Female master's degree recipients	Master's degree recipients in academic programs	Master's degree recipients in professional programs
2011	379,705	190,153	329,610 (87%)	50,095 (13%)
2012	434,742	222,780	346,575 (80%)	88,167 (20%)
2013	460,487	237,334	330,606 (72%)	129,881 (28%)
2014	482,210	252,368	311,275 (65%)	170,935 (35%)
2015	497,744	260,738	299,334 (60%)	198,410 (40%)
2016	508,927	269,502	291,715 (57%)	217,212 (43%)
2017	520,013	277,011	284,656 (55%)	235,357 (45%)
2018	543,644	295,098	285,705 (53%)	257,939 (47%)
2019	577,088	NA	290,602 (50%)	286,486 (50%)
2020	662,451	365,286	292,992 (44%)	369,459 (56%)

Source MOE (2012–2021)
Note NA suggests that the data were not reported by MOE

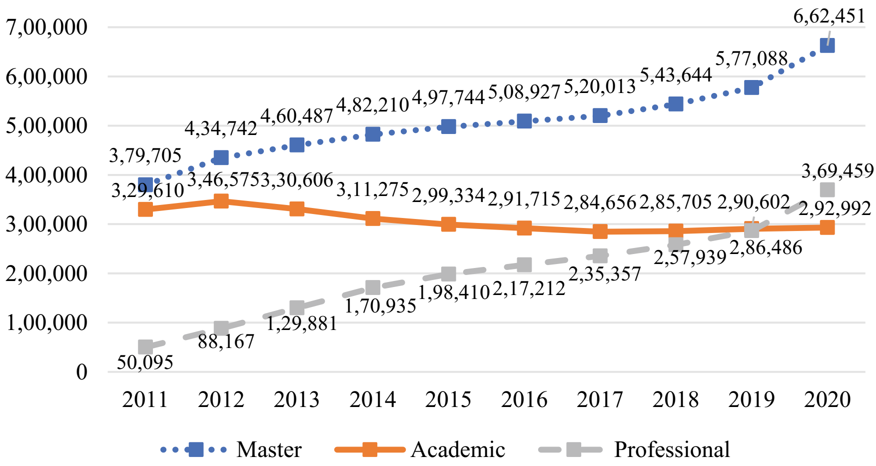

Fig. 3 Master's degree recipients in China (2011–2020). *Source* MOE (2012–2021)

10,558 more than doctorate recipients in 2011. Figure 4 demonstrates the trend of doctorate recipients in China in the last decade. Both the total number of doctoral degree recipients and the number of academic doctoral graduates have increased gradually. However, the number of professional doctoral graduates remains stable. The statistics suggest that the growth of professional education is mainly taking place at the master's degree level rather than the doctoral level and the majority of doctoral students focus on academic research.

Table 5 Doctorate recipients in China (2011–2020)

Year	Total doctorate recipients	Female doctorate recipients	Doctorate recipients in academic programs	Doctorate recipients in professional programs
2011	55,618	18,189	49,145 (98%)	1,144 (2%)
2012	51,713	19,250	50,401 (97%)	1,312 (3%)
2013	53,139	19,980	51,248 (96%)	1,891 (4%)
2014	53,653	20,588	51,675 (96%)	1,978 (4%)
2015	53,778	22,564	51,649 (96%)	2,129 (4%)
2016	55,011	21,535	52,700 (96%)	2,311 (4%)
2017	58,032	22,802	55,823 (96%)	2,209 (4%)
2018	60,724	23,887	58,450 (96%)	2,274 (4%)
2019	62,578	25,037	60,436 (97%)	2,142 (3%)
2020	66,176	27,444	63,510 (96%)	2,666 (4%)

Source MOE (2012–2021)

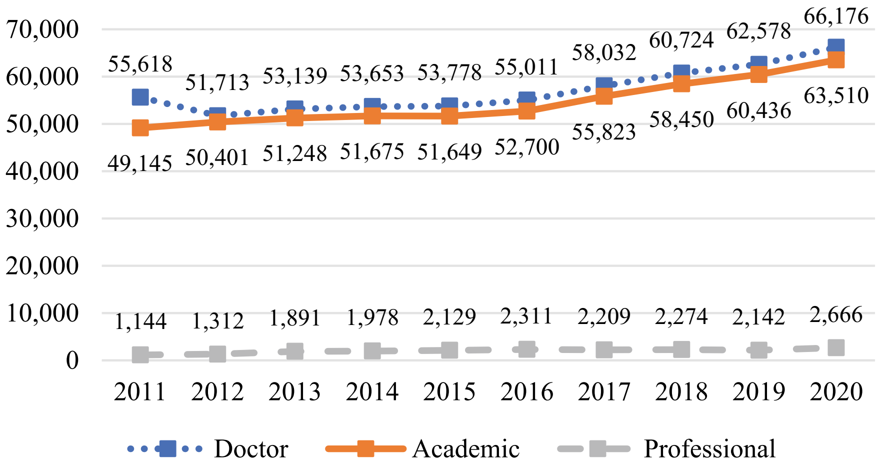

Fig. 4 Doctorate recipients in China (2011–2020). *Source* MOE (2012–2021)

2.5 *Professional Education Development in China*

Figure 5 compares the proportion of professional masters over the total number of master's student versus the proportion of professional doctoral students over the total number of doctoral students. Both proportions of professional master's and doctoral students have generally increased in the last decade. However, the proportion of professional masters is always higher than that of doctoral students.

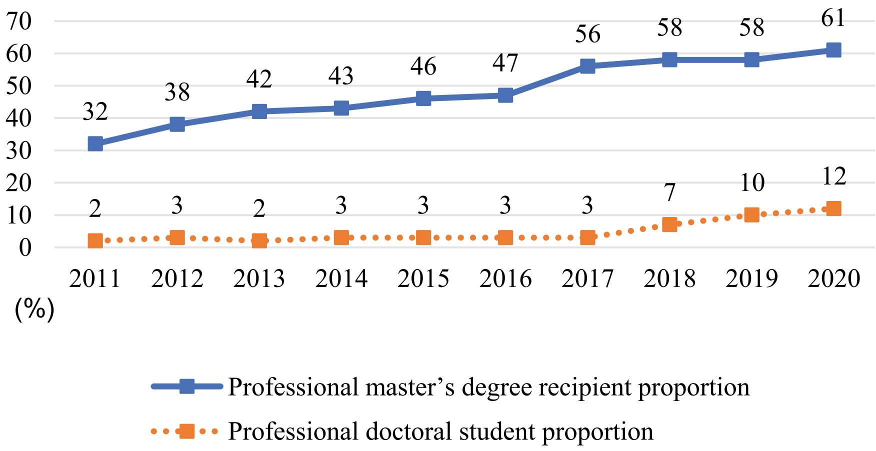

Fig. 5 Proportion of professional degree enrollments (2011–2020) (%). *Source* MOE (2012–2021)

Figure 6 compares the proportion of professional master's degree recipients over total master's degree recipients versus the proportion of professional doctorate recipients over total doctorate recipients. Compared with professional doctoral degree recipients, the proportion of professional master's degree recipients has been significantly higher in the last 10 years. Moreover, there has been a considerable increase in the proportion of professional master's degree recipients, whereas the proportion of professional doctorate recipients stays constant, demonstrating a stark comparison between professional education at master's and doctoral degree levels.

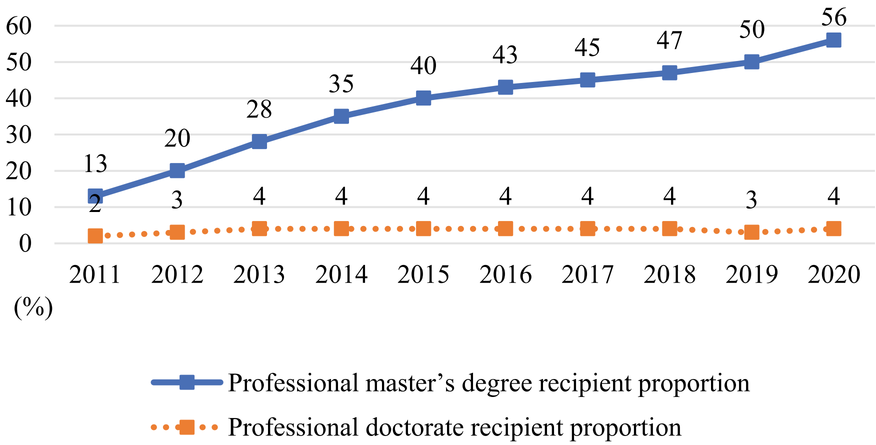

Fig. 6 Proportion of professional degree recipients (2011–2020). *Source* MOE (2012–2021)

Table 6 Professional master's student enrollments in China and the world

Master's student enrollment			
Country	Total enrollment	Enrollment in professional program (%)	Enrollment in academic program (%)
China	811,334	474,273 (58%)	337,061 (42%)
U.S	2,678,712	N/A	N/A
U.K	485,396	0	485,396 (100%)
France	996,046	692,277 (70%)	22,054 (2%)
Germany	1,070,851	0	1,070,851 (100%)
Netherlands	184,714	12,582 (7%)	172,132 (93%)
Switzerland	72,252	3,382 (5%)	68,870 (95%)
Japan	350,765	N/A	N/A
ROK	238,012	153,186 (64%)	84,826 (36%)
Russia	1,259,447	1,259,447 (100%)	0

Source OECD (2021)
Notes N/A suggests that the data was not reported by OECD; 0 suggests that OECD reported 0 in that category

2.6 Professional Master's Student Enrollments in China and the World

Previous sections present the current statues of professional education in China. To compare the enrollments of professional education in China and the world, data are retrieved from the database Education at a Glance (OECD, 2021).[1] The analysis in this section is based on number of students enrolled in different education programs by field and sex and the number of people who graduated from an education program data file from the database. Table 6 compares student enrollments in China and the other nine countries (namely, the U.S., the U.K., France, Germany, the Netherlands, Switzerland, Japan, ROK, and Russia) in terms of total master's student enrollments, professional master's student enrollments, and academic master's student enrollments in 2019, as the latest statistics available.

In terms of the total number of master's student enrollment, the U.S. ranked first among the selected countries (N = 2,678,712), followed by Russia (N = 1,259,447), Germany (N = 1,070,851), France (N = 996,046), China (N = 811,334), U.K. (N = 485,396), Japan (N = 350,765), ROK (N = 238,012), the Netherlands (N = 184,714), and Switzerland (N = 72,252).

Among the countries selected, the U.S. and Japan did not report the specific number of professional versus academic master's student enrollments but reported

[1] The indicator design and data collection framework can be found in *OECD Handbook for Internationally Comparative Education Statistics: Concepts, Standards, Definitions and Classifications* (2017), including the fundamental statistical concepts, definitions and methodologies underlying the indicators.

enrollments at the master's degree level as a whole. For the other countries, including China, the U.K., Germany, France, the Netherlands, Switzerland, ROK, and Russia, the proportion of professional and academic master's students was reported in 2019. Russia has the highest reported proportion of professional master's student enrollments (100%), followed by France (70%), ROK (64%), and China (58%). Professional master's enrollments in the three countries accounted for more than 50% of the total master's student enrollments. The Netherlands and Switzerland, on the other hand, have a relatively smaller portion of professional education, with 7% and 5%, respectively. Lastly, the U.K. and Germany reported 0% of professional enrollment and 100% of academic program enrollment.

3 Excellence Indicators

This section identifies a set of excellence indicators to evaluate professional education in China and around the world. After presenting the methodology of selecting and defining these indicators, this section presents the results of the excellence indicators and compares the findings of the professional education development in the selected universities.

3.1 Design

According to OECD (Bottani, 1994), there are three core education quality indicators including context indicators, resource and process indicators, and outcome indicators. More specifically, the context indicators denote the scenario in which the education is rooted. The resource and process indicators specify the domain of cost, resources, and school processes. Subcategories such as financial indicators, participant indicators, staff indicators, and Research and Development (R&D) indicators are all included in this domain. Lastly, outcome indicators are defined by educational results, including student outcomes, system outcomes, and labor market outcomes. On the other hand, UNESCO (Education Indicators Technical Guidelines, 2009) proposed a more complicated framework for evaluating educational systems, where additional dimensions such as gross enrollment rate, net enrollment rate, age-specific enrollment rate, survival rate by grade are also included. Based on OECD education quality indicators, UNESCO education quality indicators, and previous evaluation indicator frameworks for professional degrees (Guo & Wu, 2018; Hua & Hong, 2017; Ma et al., 2019; Tian et al., 2018), this chapter proposes a two-dimensional excellence indicator framework for evaluating the scale and educational outcome of professional education.

Among Chinese universities, 24 are listed among the Top 200 Universities by the ShanghaiRanking's Academic Ranking of World Universities (ARWU) and listed as the Double World-Class universities and disciplines by MOE's Double World-Class Project in China are included in this analysis. The Double World-Class Project aims to facilitate and foster the research and development of key disciplines at top Chinese universities (e.g., Tsinghua University, Peking University). Therefore, the 24 universities' teaching and research quality can be regarded as reflecting the highest standards of Chinese higher education.

In addition, this section collects data from world's top universities and computed the excellence indicators as references. World's top universities refer to the top-tier international universities that are ranked highest among the universities in the world and of the highest standard of excellence (Nejati et al., 2011). The global top 5 universities (Harvard University, Stanford University, University of Cambridge, Massachusetts Institute of Technology [MIT], and University of California, Berkeley [UCB]) and top 21–25 universities (i.e., ETH Zurich, University of Toronto, Washington University in St. Louis, The University of Tokyo, Imperial College London) universities are selected to represent top universities' performance on the excellence indicators. World-class universities are defined as institutions that are ranked among the foremost globally by widely acknowledged evaluation metrics of an international standard of excellence (Altbach, 2003). The universities that ranked 75–79th (i.e., National University of Singapore, The Australian National University, Fudan University, University of Bristol, Uppsala University) and 96–100th (i.e., The University of Western Australia, Carnegie Mellon University, Moscow State University, University of Florida, University of California, Davis) in the world are included to represent world-class universities.

3.2 *Definitions and Sources*

The two-dimensional excellence indicator framework assesses the scale and educational outcomes of professional education. Within the two dimensions, five indicators are designed to assess key domains. Moreover, since professional degrees are mainly provided in certain practical fields, these indicators were calculated based on seven fields: education, business & management, engineering, law, medicine, art and design, and architecture. The following subsections detail the methodological framework with respect to the dimensions and evaluative metrics (see Table 7).

3.2.1 Scale

The first dimension measures the scale of professional education including the number of professional degree programs offered by institutions, the faculty-student ratio, and the ratio of professional degree conferral against academic degree conferral. The following sections describes the calculation methods the evaluation metrics in details.

Table 7 Excellence indicators for professional education

Dimension	Indicators	Source
Scale	Number of professional degree programs offered	China Academic Degrees and Graduate Education Information Network; Universities' official websites
	Professional degree-academic degree enrollment ratio	China Graduate Enrollment Information Network; Universities' official websites
	Faculty-student ratio	Universities' official websites
Educational outcomes	Salary increase	Financial times website
	Employer reputation	QS global ranking indicator

The Number of Professional Degree Programs Offered. The number of professional degree programs offered per university provides an overview of professional degree program development affiliated with universities. This metric is an essential indicator to measure the scale of professional education. It also indicates the capacity of the education system to provide diversified programs of professional education to meet the needs of the labor market. This indicator ranges from 0–100: institutions with no professional education programs are scored zero, institutions with one-two professional education programs are scored 60, institutions with three-to-five professional education programs are scored 80, and institutions with six-to-seven professional education programs are scored 100.

Faculty-student ratio. Teaching quality is one of the most important indicators for evaluating educational institutions on their research and industry performance. Up till now, widely acknowledged global university rankings (e.g., QS, U.S. News, Times, and AWRU) all have adopted the faculty-student ratio as a key metric in evaluating teaching quality. This metric measures to what extent enrolled students can receive high-quality training regarding their future careers and have access to mentorships from qualified faculty members. This indicator is standardized to 0–100. A higher faculty-student ratio yields a higher standardized indicator score.

Professional Degree/Research Degree Enrollment Ratio. The professional degree/academic degree ratio refers to the ratio of new entrants to the professional programs against new entrants to the research programs. This measure shows the relative proportion of professional education scale against academic education. It indicates to what extent professional education is valued by the country and the labor market compared with research/academic education. This indicator is standardized to 0–100.

3.2.2 Educational Outcomes

The second dimension of excellence indicators for evaluating professional education assesses the outcomes of the professional education degree programs offered by the sampled institutions. Two essential indicators including the salary increase after obtaining the degree surveyed by Financial Times Global Ranking and employer reputation indicator surveyed by QS Ranking were retrieved from the websites.

Salary Increase. Salary increase refers to the proportion of increased salary before and after obtaining professional degrees. Due to limited data availability, the salary increase indicator surveyed by Financial Times (FT) Global MBA Ranking were used to compare MBA graduate outcomes. Salary increase indicator in other fields will be included if there are large-scale surveys conducted. This indicator is standardized to 0–100. Higher salary increase yields a higher standardized indicator score.

Employer Reputation. The employer reputation metric is derived from the indicators of QS Top University Rankings 2022, based on over 75,000 responses to the QS Employer Survey. This survey asks employers to identify those institutions from which they source the most competent, innovative, and effective graduates. This metric provides evidence for the success of professional education from a labor market perspective. This indicator is already standardized in a 0–100 format.

3.3 Findings

The analysis in this section evaluates professional education development of selected Chinese universities (Tables 8 and 9), in comparison with world's top and world-class universities in all the five indicators in standardized scores. Raw scores of all the indicators of all the included universities can be found in Appendix A. In addition, the average scores of the Chinese universities in the top 100 of ARWU, Chinese universities in the top 200 of ARWU, the world's top universities, and the world-class universities are also computed and compared with each other to conduct further analysis regarding different dimensions of professional education.

Table 8 presents the selected Chinese universities' performance in each excellence indicator. Among the Chinese universities in the top 100 of ARWU in the world, the average excellence indicators score is 59, with number of programs score of 85.71, faculty-student ratio score of 21.86, professional degree ratio of 76, and salary increase of 33.5, employer reputation of 76. Table 9 shows, among the top 200 Chinese universities in China, the average score is 58, with the number of programs score of 86.09, faculty-student ratio score of 31.09, professional degree ratio of 70.91, salary increase of 33.5, employer reputation of 68.

3.4 Discussion

The finding shows that the top 100 Chinese universities' performance on the excellence indicators (59) is the same as that of the selected world-class universities, and

Table 8 Selected Top Chinese universities' standardized performance on excellence indicators

Institutions	World ranking	Excellence indicators	Program number	Faculty-student ratio	Degree ratio	Salary increases	Employer reputation
Tsinghua University	28	43	100	23	20	0	85
Peking University	45	56	80	16	N/A	N/A	84
Zhejiang University	52	53	100	25	60	0	80
Shanghai Jiao Tong University	59	77	100	22	100	100	79
University of Science and Technology of China	63	48	60	0	N/A	N/A	67
Fudan University	77	65	80	21	100	34	78
Sun Yat-Sen University	89	75	80	46	100	N/A	59
Average of top world universities (top 100)	**–**	**59**	**85.71**	**21.86**	**76**	**33.5**	**76**
Average of world-class universities (top 200)	**–**	**58**	**86.09**	**31.09**	**70.91**	**33.50**	**68**

Notes N/A suggests that the data were not reported by the source websites

two points lower than that of the selected top universities. The top 200 Chinese universities' standardized performance on the excellence indicators (58) is the lowest but still relatively competitive when compared to that of the selected world-class universities. In general, the selected world-class universities set up more professional degree programs per university and have higher faculty-student ratio than top Chinese universities. However, top Chinese universities' professional degree ratio is more balanced and optimized than world-elite and world-class universities, thus achieving higher dimension scores. The performance differences on professional degree ratio among sampled universities might be attributed to country differences as discussed in the previous section (see Table 6). For example, OECD (2021) reported that professional masters accounted for 70% of the total enrollments in France and 100% of the total enrollments in Russia. In contrast, professional masters only accounted for 7% of the total enrollments in Netherlands and 5% of the total enrollments in Switzerland. Therefore, the professional degree ratio indicator is greatly influenced by the

Table 9 Other Selected Chinese universities' standardized performance on excellence indicators

Institutions	World ranking	Excellence indicators	Program number	Faculty-student ratio	Degree ratio	Salary increases	Employer reputation
Huazhong University of Science and Technology	101–150	67	100	49	60	N/A	60
Nanjing University	101–150	69	100	54	60	N/A	62
Xi'an Jiaotong University	101–150	74	100	29	100	N/A	65
Beijing Institute of Technology	151–200	60	80	36	N/A	N/A	65
Central South University	151–200	85	100	69	N/A	N/A	N/A
Harbin Institute of Technology	151–200	51	80	16	N/A	N/A	58
Jilin University	151–200	53	80	20	N/A	N/A	60
Northwestern Polytechnical University	151–200	46	60	32	N/A	N/A	N/A
Shandong University	151–200	83	80	N/A	N/A	N/A	86
Sichuan University	151–200	63	80	50	60	N/A	N/A
South China University of Technology	151–200	58	80	33	60	N/A	N/A
Southeast University	151–200	57	100	25	N/A	N/A	47
Tianjin University	151–200	48	80	9	N/A	N/A	55
Tongji University	151–200	62	100	20	N/A	N/A	66
University of Electronic Science and Technology of China	151–200	53	60	46	N/A	N/A	N/A
Wuhan University	151–200	68	100	43	60	N/A	68

(continued)

Table 9 (continued)

Institutions	World ranking	Excellence indicators	Program number	Faculty-student ratio	Degree ratio	Salary increases	Employer reputation
Average of top world universities (top 100)	**–**	**59**	**85.71**	**21.86**	**76**	**33.5**	**76**
Average of world-class universities (top 200)	**–**	**58**	**86.09**	**31.09**	**70.91**	**33.50**	**68**

Notes N/A suggests that the data were not reported by the source websites

country in which it is located. Professional education in China and in the world both yield satisfactory performance on employer reputation and salary increases. There are no significant differences in these two indicators between professional education in China and the world.

This section introduces excellence indicators of professional education in China and the world. It provides a detailed description of the indicator framework design, the metric selection, the implementation framework, and the calculation method. Comparisons of the excellence indicators among China and the selected countries revealed that professional education in China shows satisfactory performance regarding professional degree ratio, employer reputation, and salary increases. However, selected Chinese universities have relatively fewer programs of professional degrees per university and lower faculty-student ratio. Findings unveil the future directions that Chinese professional education should improve on. The next section examines the best practices of professional education in China, which sheds light on how China has scaled and perfected its professional education system in the last decades.

4 Best Practices

4.1 Hitting the Nail on the Head: Targeting Professional Education for Career Progression

Professional education in China aims to meet the needs of society and provide high-quality training for career progression in various fields (Zhang, 2017). **Both small-scale institutions and large-scale universities have proved that the right answer for professional education is to discriminate it from traditional academic education and base it deeply on the professional field. The China Europe International Business School (CEIBS), a small institution, has fostered one of the**

most well-known MBA programs by focusing on one professional area with an international vision and global allies.

CEIBS is a world-class business school jointly established by Shanghai government and the European Union in 1994. The motto of CEIBS is "China Depth, Global Breadth", which has guided CEIBS to grow fast over the last decades. It is the first business school in China to obtain dual accreditation from the Association of International Business Schools (AACSB) and the European Quality Development Accreditation System (EQUIS). In addition to its headquarters in Shanghai, CEIBS owns several other teaching and research campus in Beijing, Shenzhen, Accra, Ghana; and Zurich, Switzerland. As of 2021, it has been ranked top in the Financial Times Global MBA Top 100 List for six consecutive years and in the Global EMBA Top 100 List for four consecutive years. CEIBS is now recognized as the world's top-tier MBA and EMBA school on Chinese soil. As the pioneer and leading institution of management education, CEIBS is the first to offer full-time MBA programs, executive MBA programs, and executive education programs in China. Meanwhile, as one of the most globally well-known MBA and EMBA programs in China, CEIBS has accumulated valuable experience for China's management education reform that other universities and institutions can learn from (Nian & Hu, 2020).

Separated from its own endeavors, CEIBS has also been trying to foster allies in China and around the world and strengthen the impact of its alumni network. CEIBS was initially jointly run by Shanghai Jiao Tong University (SJTU), a top university in China, and the European Foundation for Management Development (EFMD), a global cooperative organization for management education and training. In the process of development, both SJTU and EFMD have made significant efforts. In 2002, the Degrees Committee of the State Council officially recognized CEIBS' MBA degree (Nian & Hu, 2020). As of 2022, CEIBS already has more than 26,000 alumni from more than 90 countries world and has provided management training for nearly 200,000 middle and senior managers at home and abroad (CIEBS, 2022a). CEIBS graduates can be found in major enterprises including PetroChina, Sinopec, China Mobile, China Unicom, Sinochem, Lenovo, Hisense, and TCL; national authority departments including the Organization Department of the Central Committee, the National Development and Reform Commission, the Ministry of Finance, and the Ministry of Commerce; and Fortune 500 companies including Motorola, HP, IBM, Nokia. Graduates from CEIBS have made important contributions to China's economic development in different fields and areas.

The practices of CEIBS emphasize the importance of focusing on professional training and distinguishing itself from academic training for professional education. **The goal from day one is to expand career opportunities and cultivate professional skills for enrolled students. Only by targeting the advancement of students' career and skill progression can professional education be successful in supporting China's rapidly changing, growing and expanding workforce environment.**

4.2 *Extending Featured Programs of Studies Based on Institution's History*

Universities and colleges should take advantage of their strong subject-matter expertise and establish new professional degree programs that suit the need of modern society. Tsinghua University (THU) provides a compelling example of building upon strong academic foundations to develop new professional master's degree programs.

THU has one of the best engineering faculty in the world. Its academic Master of Engineering has experienced decades of evolution. Based on rich experience of academic training, Tsinghua University has implemented 19 full-time engineering master training programs across 15 engineering departments. THU ability to draw upon the expertise of their pre-existing Master of Engineering programs in the development of professional education provides a model for the further expansion of professional education.

At the very beginning of 2009, THU did not realize the importance of differentiating professional education from academic education (Wang et al., 2014). Soon after, the following reforms were implemented by the university:

- The framework of the program must be designed for professional engineering masters. The training objectives, curriculum settings, evaluation standards, and practical skills should be tailored for professional education.
- It is necessary to provide students with opportunities to exercise in the field of the industry through developing professional practice bases; thus, students can use the theories they have learned to solve practical problems with research significance (Du et al., 2017).
- Students are required to take both academic and professional elective courses to maintain the high quality of Tsinghua's graduate education (Wang et al., 2014). Over the years, it has been committed to cultivating "application-oriented, compound high-level engineering technology and engineering management talents that meet the requirements of employers (Xu et al., 2010).

Rather than academic training, the main objective of professional degree programs is to provide application-oriented professional skills. During the professional degree training, course study and thesis are mainly completed on-campus. On the other hand, postgraduates must complete professional practice for a minimum of six months. Professional practices are typically offered either at the university or through an internship. Students are mentored by both faculty members on campus and experienced professionals in industry across a wide range of engineering specialties. In 2008, the first pilot cohort of master's professional engineering students was launched. Professional engineering students study a wide range of disciplines including electric power, water conservancy, environmental protection, petrochemical, construction, automobile, railway, and military industry (Wang et al., 2010).

THU's expansion of prior engineering programs proves that **high-quality professional programs can be developed from previously successful academic programs. This strategy** has been successfully replicated by many universities and colleges in China, which has greatly advanced Chinese professional education.

4.3 Establishing High-Quality Professional Programs in Response to Social Needs

In 2018, the government announced that leading universities should actively participate in the mission of fostering teacher education for elementary and secondary education. The policy brought new opportunities and challenges. Therefore, **professional education should aim to cultivate application-oriented professionals at post-secondary level with practical skills and abilities in professional fields. The best professional education should answer the national calls and meet the social needs. For example,** to answer the national calls and social needs, the School of Education (SOE) at Shanghai Jiao Tong University (SJTU) was established in late 2020 in conjunction with the School of Mathematical Sciences, School of Physics and Astronomy, School of Chemistry and Chemical Engineering, and several other schools. It aims to train high-quality teachers for in-demand STEM disciplines. As a newly founded program of teacher education, SOE, together with many other schools at SJTU, have been working hard to explore the best practice of teacher education (Liu et al., 2021).

SOE at SJTU features a young faculty with an institutional history tracing back to 1897. Nanyang College developed the first teacher education program in China. The Program of Higher Education was established in SJTU in 1985, and later became Graduate School of Education in 2007. After SOE was established, it has expanded its teaching and research focus to include elementary and secondary education fields in addition to higher education. In addition to providing professional degree programs, SOE is a research-intensive institution with two widely recognized research centers: the Center for World-Class Universities (CWCU) and the Center for Student Achievement and Human Development (CSAHD). Six additional research centers have been established since 2021 (SOE, 2022).

In response to the national call, SOE's motto is "Exploration, Practice, Interdisciplinary". In addition to the previous foundation of higher education research, SOE currently aims to cultivate outstanding future teachers, develop world-class education disciplines, and build new paradigms of teacher education in the top comprehensive universities.

To explore new pathways of teacher education, SOE proposed its featured training mode—the "Three Mentors" Strategy (Liu et al., 2021). As a school in one of the top universities in China, SOE of SJTU recruited faculty members with strong academic backgrounds who have received systematic educational research training to serve as students' first mentors. Moreover, SOE takes advantage of additional faculty to build a world-class academic college with a dual-employment teacher team. Students' second mentors come from various STEM disciplines serve as students' second mentor by providing subject-matter expertise. Additionally, third mentors are appointed from top high schools to create a team of educations with rich practical experience. The "Three Mentors" strategy helps students gain interdisciplinary background and widen their horizons with three mentors working together to guide students' coursework, subject-matter expertise, and practicum.

In a joint meeting between SOE and No. 2 High School Attached to East China Normal University, a teacher from No. 2 High School Attached to East China Normal University said that the establishment of SOE made her realize the importance of elementary education for national development and that the government and higher education institution really take actions to help advance the innovation and development of elementary education. The practice mentor team from high schools in Shanghai share and pass on their experience to the graduate students during a year-long internship.

The strong research foundation, rich sources on the campus, and close connections with high schools of SOE fostered the rapid development of teacher education program. The innovative solution of a multi-disciplinary team-based approach also meet both the practical and academic needs of educators. More importantly, this practice demonstrates how world-class universities answers the call of nation and take the social responsibility of cultivating elementary teachers by comprehensive university.

5 Inspiring Stories

5.1 Ding Zuyi: The Pioneer of Private Professional Education in China

In 1985, the forerunner of Xi'an Fanyi University, a private-owned institution dedicated to cultivating talents in translation and interpreting, was founded by Ding Zuyi with his entrepreneurial spirit. Since then, this little-known private school has sprouted and blossomed silently in the Western part of China. It has marked a breakthrough in the field of private higher education in China. In the beginning, Ding put forward the grand goal of "creating the Eastern Harvard" (NetEase, 2022). However, the founding of a new school was never easy. It took Ding four rounds of efforts and more than three decades to finally established the university.

In the process of running the school, Ding proposed and practiced six core school-management concepts, which reflect his original intention of founding the school. Among those, he repeatedly stressed the importance of professional education. He proposed that the aim of Xi'an Fanyi University (XFU) was to give a second chance to students who have failed the college entrance examination in China and provide opportunities for them to receive higher education. In addition, he encouraged students from XFU to develop interdisciplinary skills, including professional skills (i.e., knowledge and skills related to a specific domain), foreign language skills, and modern skills (i.e., technology literacy and communicative skills). The XFU aims to cultivate high-level technical talents needed by China. Apart from being professional personnel, students also have the potential to excel at educational research and practice (NetEase, 2022). These beliefs have shed light on promoting the development of Western translation and exploring pathways for private college and university system.

Ding agreed that the mission of professional education must answer the call of society. He proposed that the founding of private universities in China could provide a second chance for students who failed to enter public universities so that they have access to higher education. More specifically, he believed that the private professional education in China has three missions: first, teach students to contribute to the country; second, the interests of students should be prioritized; third, it is important to present China's private higher education to the world. As an educator, Ding saw the revitalization and growth of Chinese private higher education as his own responsibility. During the 25 years of running the school, Ding devoted himself and has been recognized and respected by all sectors of society. The motto of the school is to "Dare to be the first, uphold selfless dedication, love life as a child, and conduct virtuous deeds", which has inspired countless of graduates (NetEase, 2022).

In 2008, Ding was interviewed by China Talk and said that Chinese private professional higher education represented by XFU is a product of China's reform and opening-up, a product of the market economy, and a response to the country's urgent needs (China Talk, 2008). He strived for 20 years to explore the optimal pathway of private professional education. Until 2008, the number of current enrollments in XFU had reached 40,000 and more than 60,000 students had graduated. In 2020, XFU ranked first among Shaanxi private universities in the ARWU ranking. In 2021, the university has three national-level first-class professional program construction sites and was granted as one of the Double First-class private colleges and universities.

The strenuous establishment of the college attributed by Ding has had a revolutionary impact on China's education system. The impact goes far beyond the meaning of establishing a university. He is a creative educator and pioneer of private professional education. More importantly, he has never forgotten the original intention—education for the society, and constantly learning and improving from his trials and tribulations. Thanks to his grand vision, XFU has blazed a trail in China's education system. As one of the country's best private universities in the field of translation and interpretation. The university has received accolades around the world with its miraculous story referred to in the media. Growing into a multidisciplinary university in less than 40 years, XFU is experimental and has become a complementary to prestigious public universities in China.

5.2 *Xu Xiaonian: Random Walking Between Academia and Industry*

The primary objective of professional education is to foster candidates' practical skills in the industry. However, Xu Xiaonian set an inspiring example of transitioning between academia and industry, which he described as "Random Walking" (also known as a mathematical process) (Xu, 2011). During his career, Xu learned from both sides: he could apply theories to practice in industry and put practical experience into academic research. He is currently a Distinguished Professor at CEIBS, where he served as a Professor of Economics and Finance. His research interests include macroeconomics, finance, financial institutions and financial markets, transitional economies, and china's economic reform (CEIBS, 2022b).

Xu has achieved great success in the academia. Prior to CEIBS, Xu was appointed Assistant Professor of Amherst College, Massachusetts on Economics and Financial Markets from 1991 to 1995 and Research Fellow in the State Development Research Center of China from 1981 to 1985 (CEIBS, 2022b). In 1996, He was awarded the Sun Yefang Economics Prize in 1996, the highest Chinese economics award, for his research on China's capital markets (CEIBS, 2022b).

Xu also has rich experience in several transnational enterprises and financial institutions. He has worked for China International Capital Corporation Limited (CICC) as Managing Director and Head of Research, for Merrill Lynch Asia Pacific as Senior Economist, and for the World Bank (Xu, 2011).

In an interview conducted by Southern People Weekly (2011), Xu recalled the turning points where he jumped between industry and academia. Constant thinking about "the way out (of the poverty)" guided him through his undergraduate and postgraduate study. The eagerness of "seeing the world" incentivized him to quit job, pursue his Ph.D. in economics, and work at a university in the U.S. His research and award-winning experiences encouraged him to accept an offer from an investment bank so that he could apply theory and knowledge in real scenarios. And lastly, his interests in research pushed him back to academia. Xu returned to academia and became a professor at CEIBS after eight years of commercial banking. The rich experience of Xu enables him to tailor lectures for his students using both his industry and academic knowledge.

Born in a fast-changing era in China, Xu's experience of switching between roles in academia and industry reflects the zigzag of Chinese professional education development among post-secondary institutions. Xu spent decades figuring out where his passions were by being specialized in multiple occupations. Accumulating knowledge from both environments, he became one of the most well-known professors at CEIBS imparting hands-on knowledge to his MBA and EMBA students. Similarly, it took China several years to pinpoint the position of professional education in higher education, precisely defining the training objectives and outcome expectations, and finally establish a systematic training mode.

6 Latest Research

6.1 General Trends

This section examines research related to professional education in China over the last ten years from the China National Knowledge Infrastructure (CNKI) database. The keywords of "professional degree" and "professional education" are used in advanced search. To ensure the quality and timeliness of the analyzed literature, the China Social Science Citation Index (CSSCI) database is selected in the journal source category. The publication time range is set to cover the past decade from 2010 to 2021. Meanwhile, a comparison is made between research in professional degrees or professional education in China and the related research in the world. Web of Science (WOS) is selected as the targeted database, where Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HC) articles are included. The same keywords of "professional degree" and "professional education" are used, and the time range is set as 2012–2021.

The research literature is selected and screened based on the following criteria:

- The selection excludes news reports, enrollment brochures, school and degree site profiles, memorabilia, book news, and other documents;
- The basic elements of article keywords, authors, institutions, and references are not missing;
- The content of the article is related to professional education or professional degree.

The following analysis compares the latest research on professional education in China and in the world using the built-in data analysis and visualization tools within the CNKI database and the WOS database. More specifically, it analyzes the publication trend by year, the main themes and research areas of the included studies, and the subject domains and programs of studies of the selected research.

6.1.1 Publications Distributed by Year

Tables 10 and 11 present the search results for the number of publications on professional education against the number of publications on educational research in CNKI and in WOS respectively. The results show that generally, the percentage of publications on professional education over the total educational research published in WOS is significantly higher than that in CNKI.

Figure 7 demonstrates the published articles on professional degree or professional education in the WOS database distributed by years. The WOS search results display steady growth in the number of publications related to the professional degree or professional education as shown in Fig. 7. The year 2021 yielded the largest number of published articles, followed by 2020, 2019, and prior years. Generally, professional education has gained more and more interest and is studied at higher rates by the

Table 10 Proportion of the number of publications on professional education against the total number of educational research published in CNKI

Year	Educational research	Professional education	Proportion (%)
2010	305,651	3,192	1
2011	310,854	3,566	1
2012	325,483	5,496	2
2013	345,062	6,935	2
2014	358,377	7,821	2
2015	354,649	6,037	2
2016	370,550	12,585	3
2017	373,471	13,211	4
2018	390,733	14,486	4
2019	419,431	17,030	4
2020	379,530	17,781	5
2021	336,091	16,597	5

Source Compiled from search results in CNKI

Table 11 Proportion of the number of publications on professional education against the total number of educational research published in WOS

Year	Educational research	Professional education	Proportion (%)
2010	74,328	9,377	13
2011	79,235	10,021	13
2012	81,648	10,474	13
2013	87,315	11,424	13
2014	91,460	12,227	13
2015	97,890	12,901	13
2016	102,398	13,496	13
2017	128,575	17,777	14
2018	134,147	18,812	14
2019	151,146	21,362	14
2020	162,444	22,598	14
2021	168,348	22,716	13

Source Compiled from search results from WOS

educational researchers in China and the world. The number of publications in WOS demonstrates a slow but steady increase. The publication trend analysis indicates that professional education exhibits its importance gradually in the current education system.

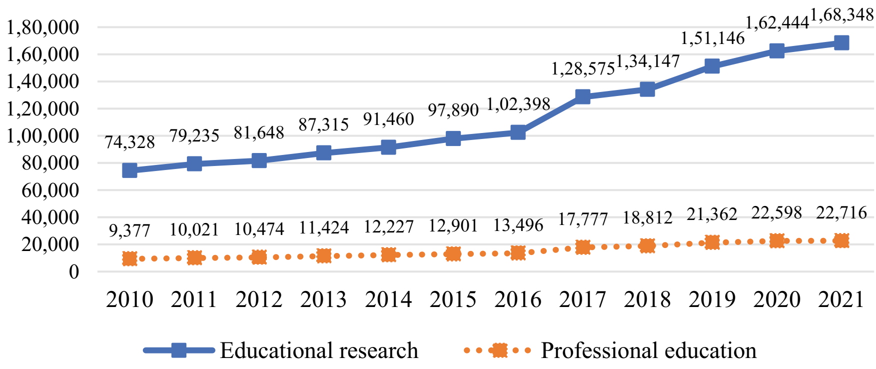

Fig. 7 Publications distributed by year in WOS. *Source* Compiled from search results from WOS

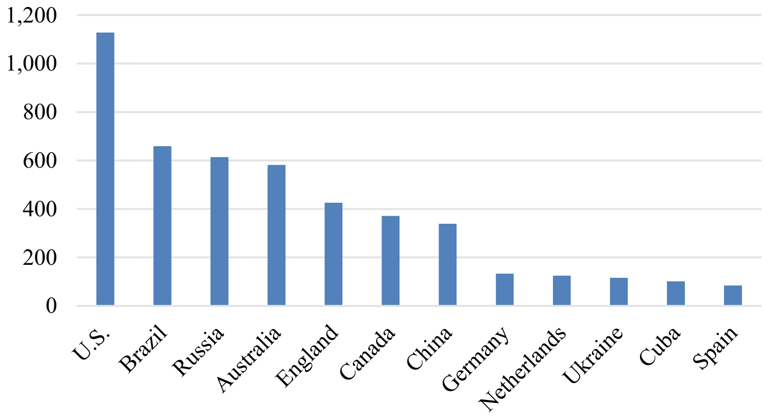

Fig. 8 Publications distributed by country in WOS. *Source* Compiled from search results from WOS

6.1.2 Publications Distributed by Countries

Figure 8 presents the number of publications from WOS distributed by the top 12 countries. The findings show that the U.S. yielded most publications on professional education or professional degrees in the last ten years, followed by Brazil, Russia, Australia, the U.K. (England), Canada, China, Germany, the Netherlands, and Ukraine.

6.1.3 Publication Distributed by Themes

Figures 9 and 10 present the publications distributed by main themes among the CNKI and WOS search results, respectively. Figure 9 shows that the top 10 themes

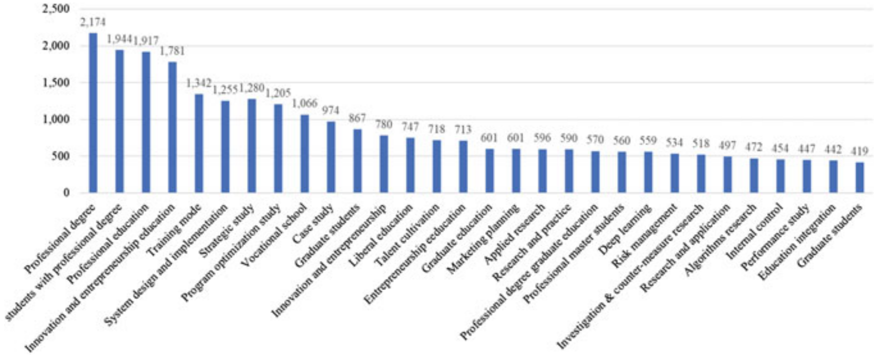

Fig. 9 Publications distributed by theme in CNKI. *Source* Compiled from search results from CNKI

among the CNKI articles are professional degrees, professional education, professional masters, innovation and entrepreneurship education, system design and implementation, training mode, optimizing study, strategic studies, vocational schools, and case studies. The results suggest that most selected studies focus on one specific professional degree or education program, regardless of programs of study or subject domains. In addition, a great number of studies examine training modes, training syllabus, and strategies or pathways to optimize professional education. Several other streams of research also emerge on their own. For example, innovation and entrepreneurship education and marketing education gained great interest from researchers (Gong et al., 2017). There are also many studies that evaluate professional education programs, including performance studies, case studies, and program optimization studies (i.e., studies on how to improve a professional degree program by optimizing its curriculum, course setting, and practicum plan). The themes analysis on professional education reveals that Chinese post-secondary institutions are striving to set up new programs that suit the needs of society. Meanwhile, researchers adopt different types of methods to evaluate professional degree programs.

Figure 10 displays the major keywords and headings among the search results from the WOS. The top 10 headings are human, female, male, adults, surveys and questionnaires, curriculum, clinical competence, middle aged, health personnel, and attitude of health care performance. Results returned from WOS indicate that research on professional education mainly focuses on areas related to medical education and health care trainings, especially for adult skill development.

6.1.4 Publication Distributed by Subject Domains

Finally, the academic subject areas are analyzed. Figure 11 shows that most articles discuss professional education as an integral part of higher education that discriminates itself from academic education instead of discussing a specific program of study

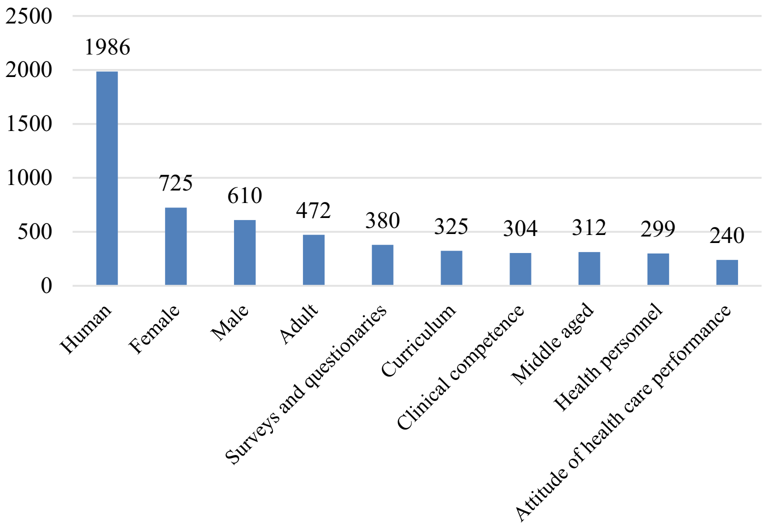

Fig. 10 Publications distributed by theme in WOS. *Source* Compiled from search results from WOS

or subject domain. The top 10 most discussed subject domains related to professional education are computer software and computer applications, business and finances, oil and gas industry, architecture and engineering, automation technology, professional education, finance, accounting, electricity industry, and medical education. Few studies are conducted on social sciences and humanities, including education and psychology.

In contrast, as shown in Fig. 12, search results from WOS reveal that the top 10 categories in the related studies are education and educational research, health care sciences, psychology, behavioral sciences, public environmental occupational health, business economics, nursing, general internal medicine, communication, and social sciences. The main research themes that emerged from WOS search results present a different pattern compared with that from CNKI. Findings reveal that most published articles from WOS are related to health care professionals or health personnel. In addition, the main themes extracted from the search results also suggest that professional education is mainly concerned with adult or middle-aged people's career advancement after graduation. Most research focuses on the personal development one can get from professional education, especially health care professional education (Ma & Zhang, 2021).

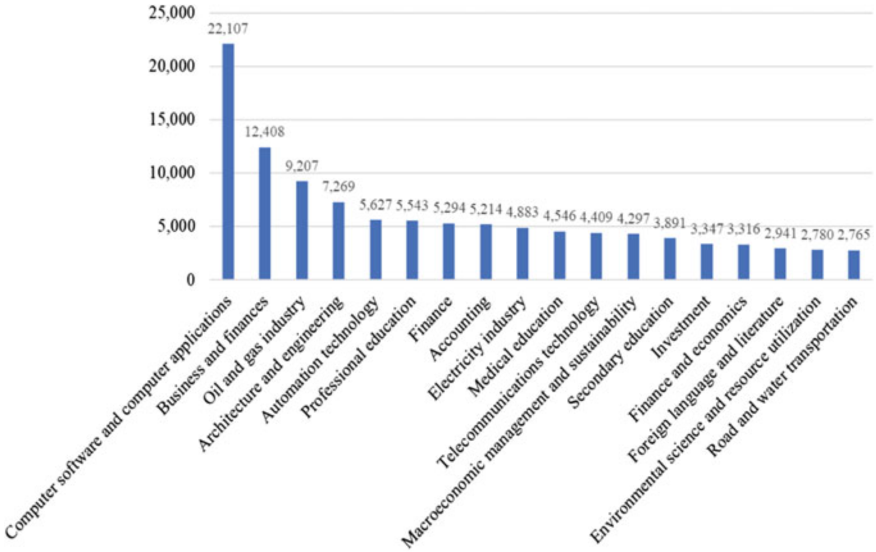

Fig. 11 Publications distributed by program of study in CNKI. *Source* Compiled from search results from CNKI

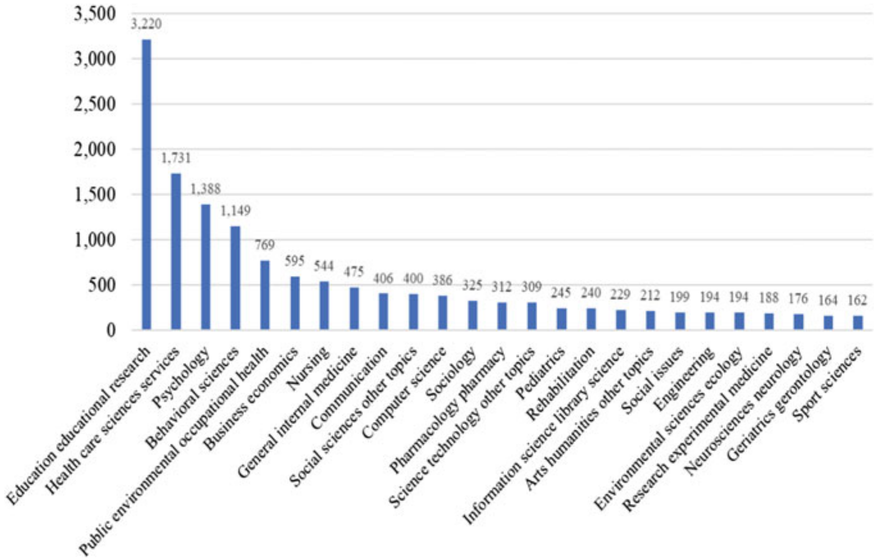

Fig. 12 Publications distributed by program of study in WOS. *Source* Compiled from search results from WOS

6.2 Discussion

The search results reveal that most articles were published from institutions such as normal universities, medical schools, and engineering faculty. Those are the major bases of professional degrees. Based on the review of the selected articles, three main research themes of professional education in China are identified and elaborated in the following sections:

- focusing on applicational and occupational subject domains;
- developing optimal curriculum and training modalities;
- exploring professional education in the new era.

6.2.1 Focusing on Applicational and Occupational Subject Domains

The results reveal that most selected studies focus on a professional degree and professional education, regardless of programs of studies or subject domains. More specifically, most research retrieved from CNKI focuses on fields including engineering, education, clinical medicine, finance, accounting, or professional degree in general. For example, Yao et al. (2022) examine the innovative competency of professional graduate students by evaluating 167 professional engineering masters' engineering creativity at Zhejiang University on six dimensions: fluency, richness, originality, feasibility, economy, and reliability. Based on the findings, they propose the following suggestions for professional education in China. First, institutions should enhance engineering activities and establish an evaluation scheme with engineering creativity as the core. Further, institutions should form an evaluation focused on students' creativity and innovative competence. Pang et al. (2022) summarize the history and current status quo of medical education in China. The authors describe the "Two Tracks in One" training mode, that is, to systematically combine the didactic training in medical schools and the clinical training in hospitals so that the professional medical students can gain theoretical knowledge and practical skills at the same time.

In contrast, few previous studies have been conducted on social sciences, humanities and art. Since the origin of a professional degree stems from social needs, findings reflect that the social needs for professional education are more related to the fields such as engineering and medicine in China in the past decades (Zhang & Dong, 2018). However, as the society advances in various fields, more research has been conducted on domains including psychology and behavioral sciences. Hu et al. (2021) argue that there is an increasing need for clinical and counseling psychology in China after the outbreak of COVID-19. Yet, there are many unresolved issues and challenges in the development of professional education, such as unclear subject orientation, mismatched training objectives between the program setup and the actual social needs, and insufficient clinical practicum. Therefore, to promote high-quality professional education in clinical and counselling psychology, institutions should establish standardized evaluation methods to evaluate professional programs' training objectives, curriculums, faculty, and outcomes. For Master of Arts, Zhang (2021) presents how Beijing Film Academy initiated the "New Talents Program" and "Postgraduate Top-Notch Talent Experimental Class" to encourage innovation and explorations in fostering cutting-edge film art talents. Until now, it has achieved breakthrough and significant effect on professional education.

To sum, although the main body of literature focuses on fields related to computer science, business and finance, and engineering, needs for different professionals evolves with social change. Accordingly, program design and training models should also be adjusted to meet current needs of the market.

6.2.2 Developing Optimal Curriculum and Training Models

A great number of studies examine the curriculum, training mode, training syllabus, developmental strategies, and pathways to optimize professional education. Zhang and Chen (2022) surveyed pre-school teachers from eleven universities and colleges to examine the development and challenges of pre-school teacher education. They probe the quality assurance mechanism for preschool education, including its development, revision, and improvement. Li et al. (2018) describe the practice of the professional veterinary degree in China and identify three core skillsets: the first category is veterinary medical knowledge and skill. The second category is management skill. The third category is high-level compound talents. With clear training objectives, veterinary professional education has achieved great breakthrough since 2000 (Li et al., 2018).

Another stream of research investigates the outcome quality and career satisfaction, which marks the transformation of professional education from its initial stage to the outcome stage. Li and Xiong (2013) introduce China's civil engineering professional education degree program, which was the first major to receive international recognition among the engineering bachelor's degrees. They further describe the relationship between engineering education evaluation and professional engineer registration system, compared civil engineering education evaluation between China and the U.K., and described the international mutual recognition pattern of civil engineering education evaluation. Zhang and Wu (2014) observe the professional education outcomes by evaluating the effectiveness of course teaching, professional practice, dissertation writing, and social work practicum among 143 social work masters' graduates of a comprehensive university for two years. Findings show that most of the students have provided positive comments on the effectiveness of social work professional education. They also identify some problems in the curriculum design and professional practicum, which leads to their low levels of confidence on theory and practice.

To conclude, different phases and components of professional education have been studied deeply to determine the optimal curriculum, training mode, training syllabus, and developmental strategies. After decades of development, outcome analyses have been also conducted to evaluate professional students' career progression after graduation to serve as feedback for program improvements.

6.2.3 Exploring Professional Education in the New Era

The last theme identified in the related literature discusses the emerging paradigms of delivering professional education in the new post-Covid era through various teaching methodologies and modalities.

The sudden outbreak of the epidemic in late 2019 has had a profound impact on education in China and around the world. Different modalities for delivering professional education are adopted to reform the traditional in-school teaching methods to blended learning or fully online learning. Wang (2022) discusses the educational transformation of music majors in colleges and universities in the post-epidemic era. She analyzes the opportunities and challenges brought by the pandemic and proposed potential new modes of music professional education in colleges and universities in the post-epidemic era. He (2021) analyzes the demand for the professional education in the health industry in the post-epidemic era. The author finds that there will be increased demand for medical innovation; the pace research and development of new medications will accelerate; the demand for innovation in high-end life biotechnology will increase; and the telehealth will develop rapidly. In addition, various needs for disease prevention and treatment will also emerge, which will promote multidisciplinary integration in the professional health care industry. He (2021) claims that these changes promote further integration and development of medical education, scientific research, and technological innovation.

In sum, the new era requires fast adaptation of technological development, in-depth research on the training mechanism, and institutional guarantees for cultivating professional students.

7 National Policies

7.1 The Fundamental Policy

In 2020, the Chinese government issued *Developmental Plan for Professional Graduate Degree Programs (2020–2025)*, in which several key issues were discussed, as shown in Fig. 13. This fundamental policy aims to increase the number of professional degrees and to establish a curriculum designed for professional degrees. Three policies soon followed and were launched to complement the general policy regarding program setup, program evaluation, and the future development trend. More specifically, the *Plan* stresses that new professional degree programs should be created based on key areas of national strategic development, and the program establishment

Fig. 13 National policies on professional education

should be based on the curriculum designed specifically for professional degrees rather than indiscriminately borrowing from academic degrees. In terms of evaluation of programs, the nation will implement a series of professional education evaluation standards and indicators, since the current evaluation indicators are adapted from prior academic degree indicators and are not well-suited to professional education. Thus, it is important to develop evaluation indicators that align to the goals and design of professional education. Essential dimensions include employment, career development, and practice. Lastly, the document suggests that China should greatly expand the scale of professional degree enrollments. In the meantime, a national professional degree committee shall be established to ensure the long-term development and alignment of professional degree programs.

7.2 Recent Policies

Table 12 details the key points of *Developmental Plan for Professional Graduate Degree Programs (2020–2025)*, followed by a series of policies that align with the key points and goals. The following sections provide a more comprehensive description of the policies and actions taken by the nation and higher education institutions.

7.2.1 Establishing a Standardized Process for Adding and Cancelling Professional Degree Programs

The *Development Plan* stresses the importance of defining the program framework and degree conferral criteria for professional master's degrees. The professional master's program design should focus on career progression and cater to the various needs of society and related occupational fields. It is important that training should

Table 12 National policies on professional education

Themes	Purposes	Policies
General policy	Guidance	*Developmental Plan for Professional Graduate Degree Programs (2020–2025)*
Establish a standardized process for adding and cancelling professional master's programs	Formulate training curriculum specifically designed for professional masters	*Official Reply to the Constitution of the National Steering Committee for the Professional Degree Education of Master of Education*
		Notice of MOE on Carrying Out Pilot Work on the Comprehensive Reform of Professional Graduate Degree Education
		Guidelines of MOE on the Training of Full-Time Master's Degree Graduates
		Guidelines on Strengthening and Improving the Work of Professional Degree Education
		Notice on the Review of the Programs for the Addition of Master's Degrees
Expand the scale of professional education	Increase the proportion of students enrolled in professional masters. Form committees for different professional programs for standardized administrative processes and curriculum	*Notice of the Degrees Committee of the State Council on Issuing the List of Degree Programs that will be Dynamically Adjusted, Revoked, and Added in 2020*
		Notice on the Change of the National Steering Committee for the Professional Master of Education
		Notice on Issues Such as Admissions for a Professional Degree for the Executive MBA (EMBA)
		Notice on the Issuance of Guided Training Programs for Graduate Students with Master's Degrees in Clinical Medicine, Stomatology and Traditional Chinese Medicine

(continued)

Table 12 (continued)

Themes	Purposes	Policies
Adopt employment-oriented indicators in program evaluation	Develop evaluation indicators for professional education based on employment, career development, and practice	*Introduction to the Professional Degree Level Assessment Work*
		Notice of the National Education Inspection Committee of the State Council on Printing and Distributing the Implementation Plan for the Evaluation of the National Professional Degree Level

help students develop a complete and systematic knowledge of their field of practice and the basic requirements for conferring a master's degree should be clearly defined. Graduate students are expected to master robust theories and demonstrate solid expertise in related industries or occupational fields. Further, graduates should develop abilities to solve practical problems through research and experiential learning.

Universities and colleges should form a more flexible mechanism for professional master's degree management. In prior years, professional master's degree categories have been added in the fields of modern manufacturing, transportation, agriculture, information technology, service industry, and social governance. It is necessary to carry out a pilot program before setting up a new professional master's degree category. Moreover, universities should constantly revise the mechanism for adding new professional degree programs. For professional master's degree programs newly developed by colleges and universities, they should have formed a certain scale of professional education and be recognized by the society and the industry for official approval by the Degrees Committee of the State Council. If an institution can present evidence on the long-term satisfactory performance on student enrollments and graduation, the Degrees Committee of the State Council will officially approve the new program. Universities and colleges, industry can also submit applications for the establishment of master's degree categories using the same procedures as long as the programs meet the social needs.

7.2.2 Expanding the Scale of Professional Education

China will continue to promote the growth of professional education for master's degrees and expand the academic offerings of professional master's degree programs. The integration of industry and education is emphasized by many specialization areas (Chen et al., 2020). In addition, the development of practicum sites is regarded as an important component for evaluating a master's degree program, although it is not a mandatory requirement for an academic degree program. The government continues to instruct degree-granting units to optimize the scale and proportion of professional postgraduate students to increase overall student enrollments (Tang & Wang, 2017).

Moreover, the country will further expand the scale of postgraduate education for professional doctoral degree programs. Increasing professional doctoral degree programs are added including degrees in clinical medicine, engineering, and education. The existing academic doctoral degree programs should not be regarded as preconditions for the addition of professional doctoral degree programs. Instead, the most essential conditions for the addition of doctoral degree programs are integration of production and education and collaboration between universities and industry.

In addition to the expansion of professional masters and doctors, the regional distribution of doctoral degree programs will also be improved to support regional social and economic development (Li & Yang, 2017). Continued innovation and change in these areas should lead to the increased recruitment of postgraduates.

7.2.3 Adopting Employment-Oriented Indicators in Professional Program Evaluation

Universities and colleges should construct optimal mentorship teams for professional education. Newly recruited research mentors for professional masters should have research or practical experience in industry. Experienced professionals are also required by the mentor team so that enrolled students can carry out research and practice in the industry (Li et al., 2019). Moreover, institutions should set up high standards for selecting the professional mentors. Thus, a dual mentor system for professional masters can be formed (Ma et al., 2021).

Universities should advance the reform of professional education curriculum for the integration of industry and education. Mentors should invest more efforts on professional ethics education and emphasize students' future career progression. Universities are also encouraged to formulate joint training programs with industry, setting up unique practical courses and teaching materials. Government-qualified sectors are even encouraged to develop professional and technical ability standards to promote the evaluation of professional education.

MOE sets to improve the evaluation of professional graduate students. Specifically, the evaluation indicators should be application-oriented. Professional masters no longer need to complete academic dissertations to receive degrees. The final project can be presented in the form of dissertations, research reports, planning and design, product development, case analysis, project management, and works of art. For professional doctorates, dissertations should demonstrate the ability of independently undertaking highly technical work and making innovative applications in specialized technology.

Moreover, the evaluation method for professional degree programs should be improved by incorporating industry-related indicators. Universities should avoid evaluating professional education by simply counting the number of published papers. Instead, it is important to assess the quality of professional degree programs primarily on their course settings, practicum offered, and connections to industry.

To summarize, this section reviews the core policies related to the establishment, development, and evaluation of professional education in China. In general, professional education will continue to be greatly expanded in both the number of programs and enrollments over the next decade. Moreover, administrative committees for different fields including the Degrees Committee of the State Council, the Education Steering Committee of the State Council, and MOE have been developed to monitor the further development of professional education in China. Further, they have worked together to develop policies and documented regulations to ensure the quality of professional education.

8 Summary

Professional education is an indispensable part of higher education. It aims to cultivate application-oriented professionals with solid practical abilities in occupation practice. This chapter introduces the history, current status, types, highlighting data, excellence indicators, best practices, inspiring stories, national policies, and latest research of professional education in China.

Highlighting data presented in this chapter find that China has advanced greatly since the first professional degree program was set up in 1991 and established a wide range of professional programs covering fields like business and finance, management, education, engineering, medicine, art and design, and architecture. Moreover, China has gradually increased enrollments, graduates, and the scale of professional education. In comparison with global professional master enrollments ranks high among the selected countries, demonstrating the positive effect of related national policies on enlarging the scale of professional student enrollment.

Furthermore, this chapter provides excellence indicators to analyze professional education development. The analysis provided a step-by-step description of the indicator framework, metric calculations, and presents the results for universities in China and the world. Overall, China performs competently on various dimensions of professional education including professional degree ratio, employer reputation, salary increases, professional degree programs per university, higher faculty-student ratio, whereas top Chinese universities have relatively fewer programs of professional degrees per university and lower faculty-student ratio. The composite score of excellence indicators of the Chinese universities in the top 100 of ARWU is the same as world-class universities and close to world's top universities.

In addition to highlighting data and excellence indicators presented above, the chapter also illustrates the philosophy of practice, success achieved, inspiring stories, and related national policies in professional education in China. The best practices and inspiring stories both suggest that professional education must be established on solid academic foundation, evolve with social changes, be aligned to the practices of industry, and adapt to latest national needs. In addition, China has made great efforts to explore and implement optimal pathways to develop the Chinese mode of professional education as evidenced by latest research and launched national policies.

To conclude, professional education provides great opportunities for career progression and practical skill development. To date, professional education in China has achieved significant outcomes and fostered a great number of professionals in various fields. Further investment will be made by the country, universities, and colleges to advance professional education in China.

Appendix A

Institution	Rank	Number of Program	Faculty-student ratio	Degree ratio	Salary increase	Employer reputation
Tsinghua University	28	6	11.5	13.1	60	85.1
Peking University	45	5	10.2	N/A	N/A	84.1
Zhejiang University	52	7	11.8	1.2	60	80.0
Shanghai Jiao Tong University	59	6	11.3	3.0	110	79.3
University of Science and Technology of China	63	2	7.3	N/A	N/A	67
Fudan University	77	5	11.1	4.4	77	78.3
Sun Yat-Sen University	89	5	15.7	2.9	N/A	59
Huazhong University of Science and Technology	101–150	7	16.2	1.2	N/A	60.4
Nanjing University	101–150	7	17.1	1.1	N/A	62.1
Xi'an Jiaotong University	101–150	6	12.5	4.6	N/A	65.1
Beijing Institute of Technology	151–200	5	13.8	N/A	N/A	65.2
Central South University	151–200	7	19.9	N/A	N/A	N/A
Harbin Institute of Technology	151–200	3	10.2	N/A	N/A	57.8
Jilin University	151–200	5	11	N/A	N/A	59.5
Northwestern Polytechnical University	151–200	2	13.2	N/A	N/A	N/A

(continued)

(continued)

Institution	Rank	Number of Program	Faculty-student ratio	Degree ratio	Salary increase	Employer reputation
Shandong University	151–200	5	N/A	N/A	N/A	86
Sichuan University	151–200	5	16.4	1.8	N/A	N/A
South China University of Technology	151–200	4	13.3	0.6	N/A	N/A
Southeast University	151–200	7	11.8	N/A	N/A	47.4
Tianjin University	151–200	5	9	N/A	N/A	55.4
Tongji University	151–200	6	10.9	N/A	N/A	66.3
University of Electronic Science and Technology of China	151–200	2	15.6	N/A	N/A	NA
Wuhan University	151–200	7	15.2	1.7	N/A	68.5
Top 1–5						
Harvard University	1	7	9.5	2.5	N/A	100
Stanford University	2	7	7.3	N/A	N/A	93.1
University of Cambridge	3	7	11.1	N/A	N/A	95.8
Massachusetts Institute of Technology (MIT)	4	4	8.4	N/A	N/A	95.8
University of California, Berkeley	5	7	18.9	0.5	N/A	87.4
Top 20–25						
ETH Zurich	21	4	15	0.1	N/A	84.0
University of Toronto	22	7	25.5	0.5	N/A	77.8
Washington University in St. Louis	23	7	11.6	2.0	N/A	57.1

(continued)

(continued)

Institution	Rank	Number of Program	Faculty-student ratio	Degree ratio	Salary increase	Employer reputation
The University of Tokyo	24	7	10.6	0.1	N/A	86.8
Imperial College London	25	4	11.3	3.5	N/A	85.5
Top 75–80						
National University of Singapore	75	6	18.8	2.4	N/A	92.2
The Australian National University	76	5	17.6	N/A	N/A	79.1
Fudan University	77	6	11.1	4.4	77	78.3
University of Bristol	78	6	14.4	0.5	NA	70.1
Uppsala University	78	5	16.5	NA	NA	62.3
Top 95–100						
The University of Western Australia	96	5	21.3	3.8	NA	66.9
Carnegie Mellon University	97	4	13.5	NA	NA	74.0
Moscow State University	98	6	9.1	NA	NA	87.2
University of Florida	99	7	16.3	0.2	NA	64.5
University of California, Davis	100	6	13.2	0.2	NA	65.5

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Chapter 8
Global Comparison of Education Systems

Xiong Ziyin

Abstract This chapter combines the quantitative data with the rich qualitative evidence and triangulates the diverse evidence to systematically unearth themes and provide an in-depth review of China's dynamic education system. This chapter not only presents a benchmark study showing how China's education systems perform vis-a-vis other national education systems, but also probes into the policies and practices to reveal the contextual factors contributing to the unique patterns of China's education system.

Keywords Education system · Comparative education · Education quality

1 Introduction

From a global perspective, this chapter examines education systems at a national level. The concept of education systems borrows the idea of "system" from a broad definition in social science, which refers to a group of interacting or interrelated elements that act according to a set of rules to form a unified whole (Backlund, 2000). In the sphere of education, the idea of education systems typically encompasses all the elements involved in education, such as funding, facilities, staffing, curriculum, pedagogy, regulations, and policies. These elements are interrelated and organized strategically to achieve overarching educational goals. In other words, using the term "education system" aims to deconstruct the complex and multifaceted nature of education. By doing so, this chapter is able to present an overall and comparative view of the education systems in selected countries.

Based on the acknowledgment that students' learning pathways vary among countries and regions, this chapter begins with a brief introduction of the education systems in selected countries, including Australia, Canada, China, France, Germany, Japan, Russia, Singapore, the United Kingdom (U.K.) and the United States (U.S.). The

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Table 1 ISCED coding of education levels

ISCED coding of education levels	
ISCED 0	Pre-elementary education
ISCED 1	Elementary education
ISCED 2	Lower secondary education
ISCED 3	Upper secondary education
ISCED 4	Post-secondary non-tertiary education
ISCED 5	Short cycle tertiary education
ISCED 6	Bachelor's equivalent level
ISCED 7	Master's equivalent level
ISCED 8	Doctoral or equivalent level

Source UIS (2012)

learning pathways serve as the foundation of the education systems, which determine when students start their education, what academic tracks students can choose, and how students can move vertically or horizontally to achieve their education goals. A well-designed education system provides flexible learning pathways for its learners and avoid potential social segregation (OECD, 2020).

This chapter reviews the learning pathways of education systems at the basic education level by referring to the International Standard Classification of Education (ISCED). ISCED, developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), which provides a common framework to benchmark education systems across nations (UNESCO Institute for Statistics [UIS], 2012). This chapter adopts the ISCED 2011 classification to present the learning pathways in each nation. The scope of this chapter covers only the basic education level which includes elementary education (ISCED 1), lower secondary education and upper secondary education (see Table 1). While a snapshot of the learning pathway is provided, the distinctive features embedded in these education systems are also highlighted.

1.1 China

The People's Republic of China (hereafter "China") has the world's largest population of school-aged children. Its education system accommodates over 291 million students with more than 18 million teachers serving in 520,000 schools (excluding private education) (Ministry of Education [MOE], 2022). In 1986, the Chinese government regulated nine-year compulsory education in its legal framework, with the aim to provide elementary education and lower secondary education to every child in the country.

After completing nine-year compulsory education, students can choose from two distinctive learning tracks provided. One is the academic track and the other is the

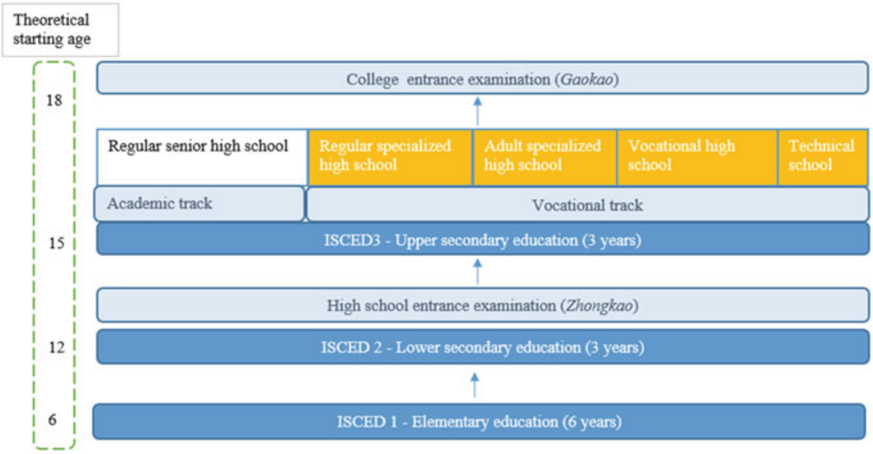

Fig. 1 The education system in China

vocational track. On the vocational track, there are four major types of schooling available, including regular specialized high schools, adult specialized high schools, vocational high schools, and technical schools. One of the major distinctions among them is the difference in the governance bodies and the institutes issuing the certificates. Among the four programs, regular specialized high schools tend to be the mainstream one, which attracts most vocational students. However, compared with the academic track, the vocational track is overall less attractive to Chinese students and their parents (Fig. 1).

1.2 The U.K. (England Only)

The education system in the United Kingdom (U.K.) is a devolved matter with each of the jurisdictions having separate systems overseen by separate governments. The U.K. government is responsible for the education system in England, whereas education systems in Scotland, Wales and Northern Ireland are governed by their respective governments. This section only discusses the education system in England.

England also has a tradition of independent schools and home education. In England, the learning tracks in the state-funded education system are categorized into "key stages" based upon age. It begins with Early Years Foundation Stage (aged 3 to 4). Elementary education (aged 5 to 10) is subdivided into Key Stage 1 (aged 5 to 6) and Key Stage 2 (Juniors, aged 7 to 10). Secondary education (aged 11 to 15) is further split up into Key Stage 3 (aged 11 to 13) and Key Stage 4 (aged 14 to 15). Above Key Stage 4 is the post-16 education (ages 16 to 17) and tertiary education (aged over 18). The law has legitimized the compulsory education for all children under 18 years old. Unlike some countries where there is a clear boundary between

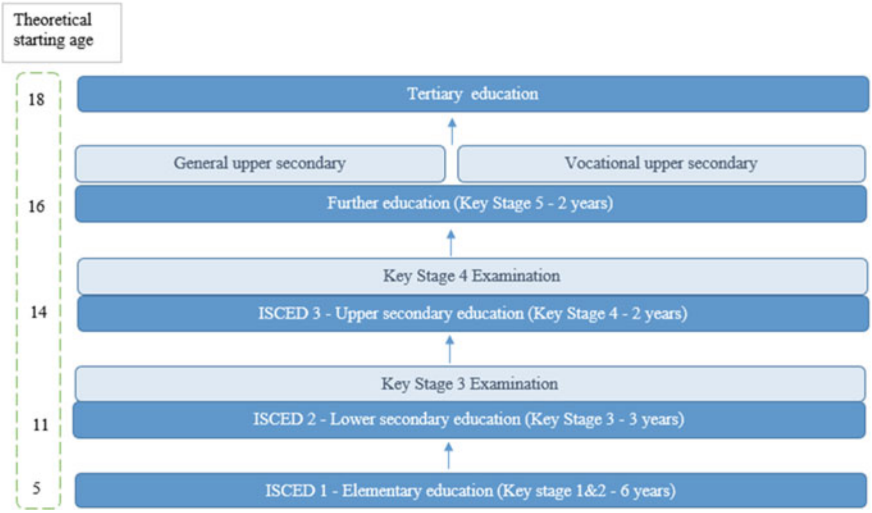

Fig. 2 The education system in England

lower secondary education and higher secondary education, England unifies the two education levels and organizes them as an integrated whole. In the final two years of secondary education (normally at the age of 15 or 16), students typically take a General Certificate of Secondary Education exams (GCSE) or other Level 1 or Level 2[1] certificates of which the result is important for those students in pursuit of further academic qualifications. The division of academic and vocational tracks normally takes places after the completion of secondary education (*education* is compulsory until 18, but *schooling* is compulsory to 16, so post-16 education can be academic or vocational). In terms of higher education, students in England often start with a three-year bachelor's degree followed by postgraduate studies (Fig. 2).

1.3 The U.S

The U.S. adopts a decentralized approach to organize its education system. Education systems adopt various forms across each state. Biggest changes at the state-level include funding, policy, curriculum, and licensing – the overall structure is very similar nationally. While differences exist across the states, this section intends to provide information and common features of how education at the basic level is organized in the U.S.

The age for starting schooling is between five to seven, depending on each state's regulations. The number of years for compulsory education also vary among states. Around 30 out of 50 states promote 11-year compulsory education. It is

[1] The standards of different levels are based on the U.K.'s national qualification frameworks.

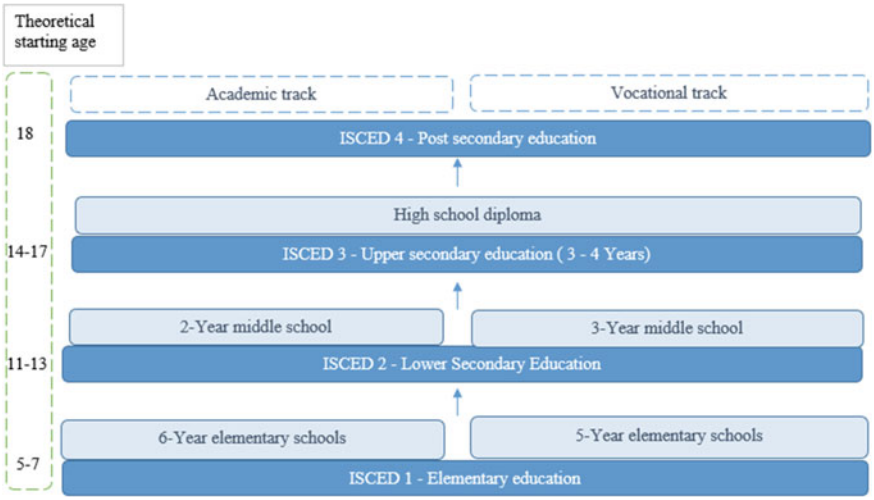

Fig. 3 The education system in the U.S

worth mentioning that although 11-years are compulsory, basic education typically comprises 13 years of education (K-12). Unlike some countries where there is a clear distinction between the academic track and the vocational track, the U.S. tends to integrate the two tracks into general secondary schools. Instead of providing vocational-oriented schools, the education system in the U.S. tends to spread out the vocational-oriented courses through the academic learning during secondary education. The intention is to broaden students' learning experiences, cultivate students' career interests through a wide spectrum of vocational and academic oriented courses (Fig. 3).

1.4 *Russia*

Education services in Russia are regulated by the Ministry of Education and Science. Russia offers a relatively long compulsory education period, which is 11 years including four years of elementary education, five years of basic general education (equivalent to lower secondary education) and two years of upper secondary education. Children must attend school when they reach the age of seven. The boundary between elementary education and lower secondary education is not clear. Typically, state-run schools offer both education levels to students.

Learning tracks split at the upper secondary education level. The general learning track offers students a two-year academic-oriented education program. Once students complete the general upper secondary education, they are obliged to pass the unified state examination (USE). Math and Russian language are compulsory exam subjects, whereas other subjects are up to students to select other exam subjects to align

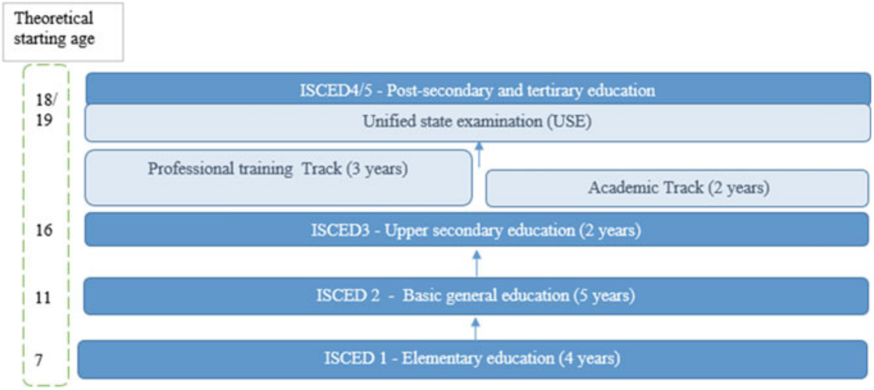

Fig. 4 The education system in Russia

with university-specific admissions standards. Another track at the upper secondary education level is the vocational training track, which offers a three-year long vocational education program (Fig. 4).

1.5 Germany

In Germany, once children reach the age of six, they are obliged to attend elementary and secondary education in Germany. Compulsory education includes four years' elementary schooling and six years' lower secondary schooling. The division between academic-oriented track and vocational-oriented track begins after the completion of elementary education.

There are various lower secondary schools available in Germany's education system. The typical ones are namely, Gymnasium (Academic oriented school), Hauptschule (vocational oriented school) and Realschule (comprehensive lower secondary school). Gymnasium represents the general track, which emphasizes academic learning and requires high marks for admissions when compared with the other two schools. Hauptschule offers schooling to young students whose grades are average or below. There are academic subjects offered to students, but the curriculum and content are adjusted to the level of Huaptschule students. In addition, Work Studies are included in the Hauptschulen curriculum but not in the Gymnasium curriculum. Realschule is another type of lower secondary school, which ranks between Hauptschule and Gymnasium in terms of academic requirement for admission. Realschule offers an extensive education service that prepares students to pursue both vocational learning and academic learning in the future (Kotthoff, 2011).

One of the well-known strengths in Germany's education system is that the dual system exists in German vocational schools. The dual system combines apprenticeships at company and vocational education at schools as an integrated program.

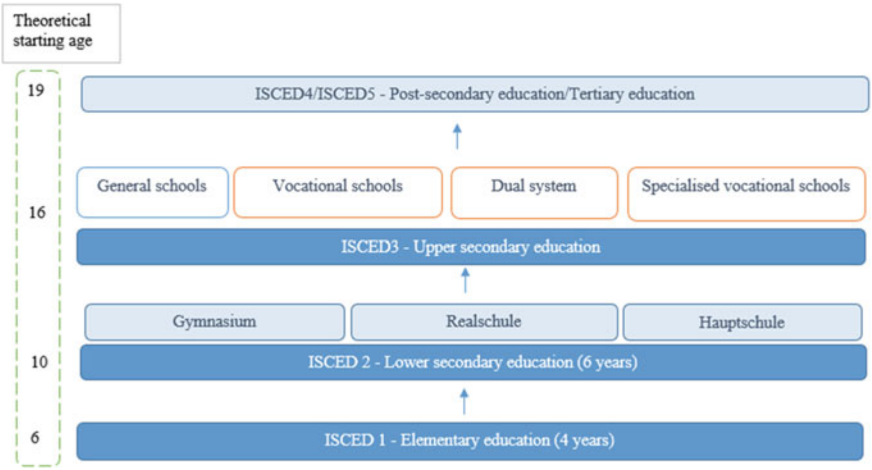

Fig. 5 The education system in Germany

Germany published the vocational training act which provides a common standard and framework to regulate the dual systems in Germany. The dual system has yielded positive educational results. For example, during the 2008 economic crisis, young German people are more resilient in the labor market than their peers in other OECD countries (Kuczera & Field, 2010) (Fig. 5).

1.6 Australia

Compulsory education in Australia typically lasts for 12 years, which is longer than many education systems introduced in this chapter. The starting age varies between the ages of 4 and 6 and the education lasts until the ages of 15, 16 and 17, depending on the state or territory.

The learning track typically diverges in the final year of the lower secondary education. Students who intend to follow the vocational learning track enroll in further courses at registered training organizations (RTOs) once they complete lower secondary education. RTOs typically provide vocational education services under the direction of the national government. RTOs include both government-owned institutes and private colleges. Vocational education track has a clear qualification framework regulated at the national level, which provides pathways for vocational education students who intend to enter the higher education pathway. Students who obtained certain levels of qualification (e.g., diploma level and advanced diploma level) are allowed to enter higher education (Fig. 6).

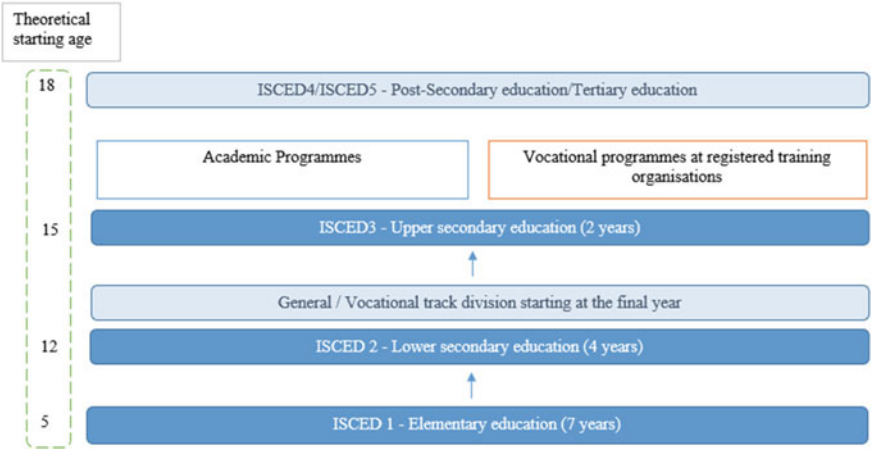

Fig. 6 The education system in Australia

1.7 Canada

Education is governed by the provincial, territorial, and local governments in Canada. The education system is mainly regulated by provincial jurisdiction and each province also oversees the curriculum. Despite differences across the provinces, the education systems in Canada still have some similar features in its structure (Fig. 7).

The age for students starting elementary education in Canada is six. It takes six grades to complete elementary education. Secondary education is divided into junior high schools (intermediate level) and high schools, which can be viewed

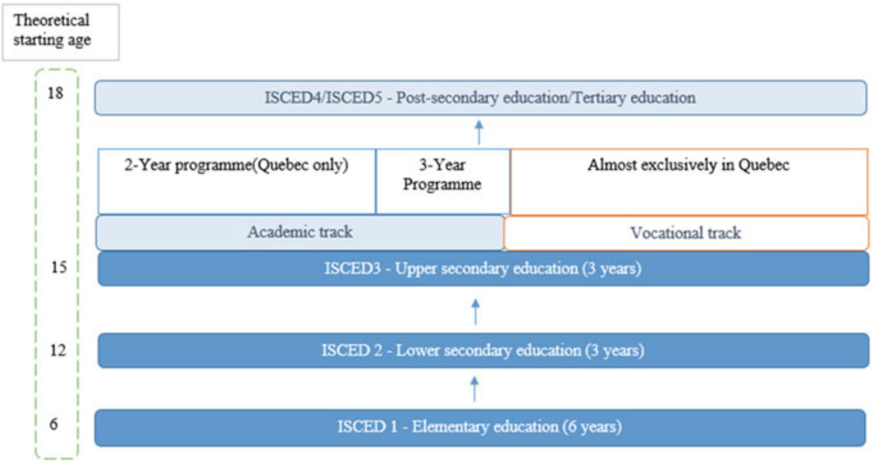

Fig. 7 The education system in Canada

as lower secondary education and upper secondary education. Generally, most provinces require children to stay in school until the age of 16. Some provinces, like Ontario, offer compulsory education for students until 18 years old. There is no clear boundary between the academic track and vocational learning track, with most secondary schools focus on general learning. In Quebec, when students complete high schools and reach the age of 16, they can then enroll in CEGEP, a public-funded two-year college where students can pursue either a university preparation program or a vocational diploma program.

1.8 France

The education system in France is highly centralized and the national government has enforced a consistent education system across regions. By law, all children must go to school until they reach the age of 16. Elementary education normally starts when children reach the age of five and takes five years to complete. Middle school is equivalent to the ISCED 2 level – lower secondary education. Students study four years at middle school, and then move into high schools or upper secondary education, which offers a three-year course to prepare students for pursuing higher education studies or the professional life.

Compared to Germany, the division of academic learning and vocational learning in France takes place in a rather late stage, i.e., the upper secondary education. There are three types of learning tracks available at this stage, i.e., lycée general (general high school), lycée technologique (technological high school), and lycée professionnel (vocational high school). Students who perform well academically typically enroll in the two former tracks. While students who pursue lycée professionnel (vocational high school) follow a more vocational track. The Lycée technologique (technological high school) specifically prepares students who want to pursue a specific technological related domain, e.g., engineering and computer science, or go to specific technological higher education institutions. In recent years, many high schools have become more comprehensive and include all three learning tracks to suit various needs of students (Fig. 8).

1.9 Singapore

The education system is highly centralized in Singapore. The central government sets the framework for the education system and oversees all levels of education. Elementary education takes six years, followed by four to six years of secondary education. There is no clear boundary between lower secondary education and upper secondary education. Instead, integrative secondary education is implemented. Its length depends on the learning track that students follow. There are three divergent tracks offered to students at the secondary education level, and students select which

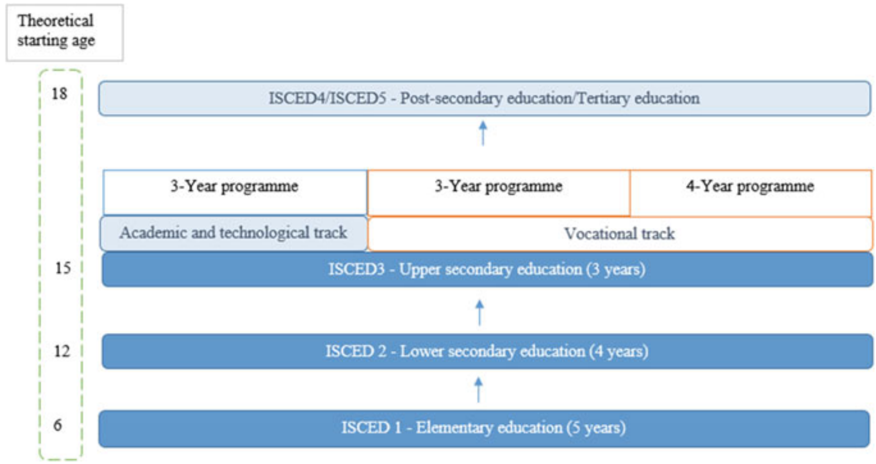

Fig. 8 The education system in France

one of them once they complete as part of their elementary education. The three are normal academic track, normal technical track and express track. All tracks offer the same courses, but the express track is faster and shorter in length and the normal technical track offers students more applied and work-oriented courses. Students are allocated into the three tracks based on their performance on the Primary School Leaving Examination (PSLE).

1.10 Japan

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) is in charge of Japan's education system. The overall education system from elementary education to secondary education is consistent across the nation despite municipality (Fig. 9).

Compulsory education in Japan includes elementary education and lower secondary education: six years of elementary and three years of lower secondary schooling. Almost all Japanese students continue to pursue upper secondary education. At this level, the learning track starts to diverge. Most Japanese students still choose to follow the academic learning path although it is competitive. High schools select students based on their performances. Each high school has their own admission process, and most schools require students to take admissions tests.

In addition to the academic path, students' other options include enrolling in specialized vocational high schools, technology colleges and specialized training colleges. Also, to nurture a talented workforce that meets the development needs of Japan, Japanese government has created a set of "Super High School" programs, specifically training students in science, global studies, and professional studies with

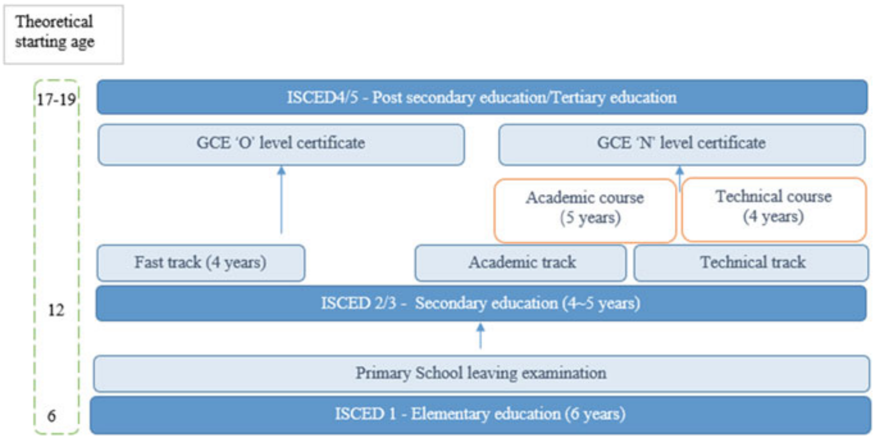

Fig. 9 The education system in Singapore

a focus on the fields of science and technology. These programs are intended to prepare a group of potential young scientists and experts for Japan. Some students attend technology colleges which provide students with several technical and engineering programs. The specialized training colleges provide more targeted and specific vocational courses, which do not require any entry exams (Fig. 10).

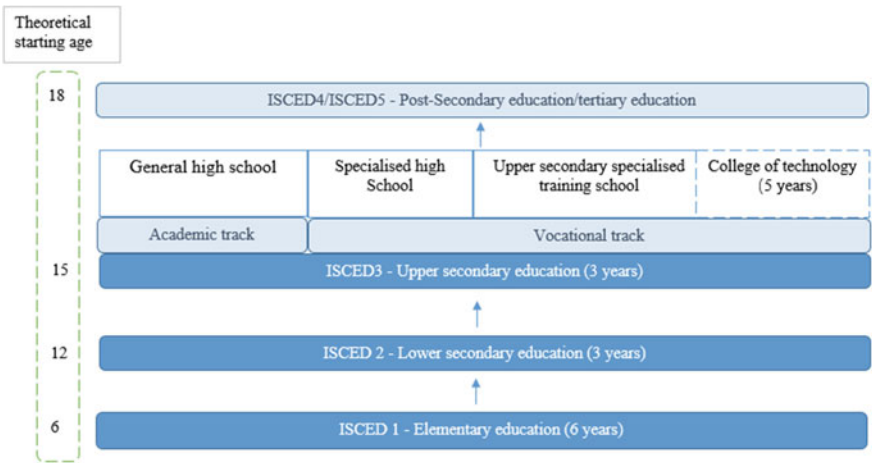

Fig. 10 The education system in Japan

2 Highlighting Data

This section intends to analyze the performance of China's education system through a global lens. Several quantitative data are collected and organized to benchmark China against other education systems around the world. Such comparison will provide empirical evidence that characterizes the features of China's education system. The analysis highlights the education transformation and trends in China in the past decade.

2.1 Gross Enrollment Ratio

"Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" has been set as one of the fundamental sustainable development goals by the United Nations (UIS, 2016). Having equal access to education is a basic right for every child. All education systems around the world should ensure this right be fully fulfilled.

One important indicator for understanding students' participation in education is the enrollment rate of each education program. The enrollment rate calculates the ratio of students enrolled in the education programs to the total population of school-age students. Internationally, net enrollment ratio and gross enrollment ratio are commonly used. Net enrollment ratio excludes the under-aged and over-aged students enrolled in the program in the calculation, whereas gross enrollment ratio includes all the students, regardless of their ages. In this section, the gross enrollment ratio is adopted for the analysis due to the unavailability of the net enrollment ratio for some education systems selected in this section (Fig. 11).

In China, the enrollment ratios of elementary and secondary education have all reached above 100%, which indicates compulsory education in China has achieved universal access in general. However, this data should be interpreted with cautions as under-aged and over-aged students are included and may contribute to a high ratio of the gross enrollment. The enrollment ratios at the elementary, lower secondary and upper secondary education level in other countries in this study are all close to or above 100%. At the upper secondary education level, the gross enrollment ratios in many countries are above 100% by a noticeable margin, indicating a larger portion of the over-aged and under-aged students in their education systems. However, in China, this indicator is rather low, i.e., around 80%, showing that there are still some upper secondary school-aged people remaining out of schooling.

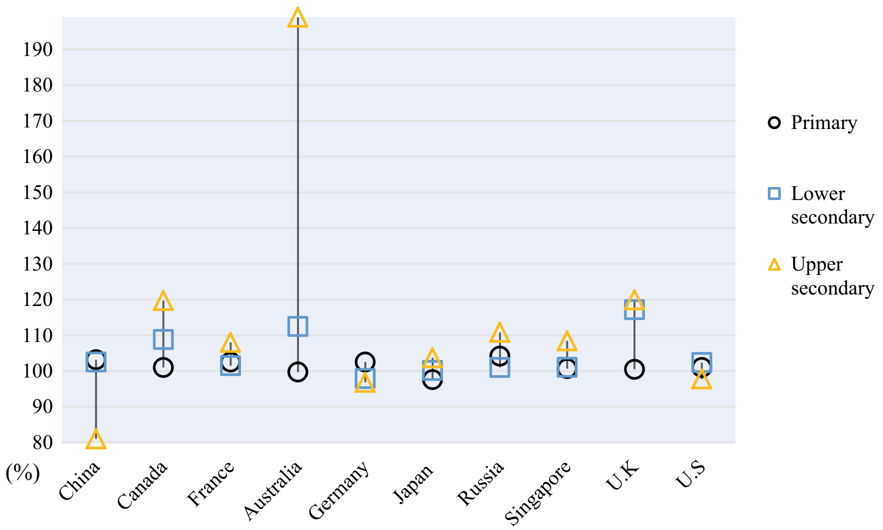

Fig. 11 Gross enrollment ratio at elementary and secondary education level (%). *Sources* Adapted from UIS (2020). *Notes* The scope of upper secondary education in the analysis, based on ISCED's definition (2011), includes the final stage of general and vocational education programs. Programs which do not require the completion of lower secondary education for entry, or do not have the cumulative duration after the elementary education, are excluded

2.2 Completion Rate

The completion rate measures the percentage of school-aged students who have successfully completed the corresponding education program. This indicator provides insights into the progress through the education system, which to some extent reflects the overall quality of schooling that children and young people receive.

A high completion rate means a large portion of children and adolescents have completed a given education level by the time they are three to five years older than the theoretical age of entry into the last grade of the given level of education. On the contrary, a low completion rate may be partially caused by the high drop-out, high repetition, late completion, and other reasons existing in its education system (Fig. 12).

Due to limited availability of data, here only the education systems of China and the U.S. are presented. As shown in the figure above, the completion rates at the elementary and lower secondary education levels in both countries are high and the gaps are insignificant. At the upper secondary education level, China's completion rate is around 60%, which is lower than the U.S. by a noticeable margin. However, the relatively lower completion rate in China is associated with the lower participation rate at the upper secondary education, which does not necessarily indicate ineffective progress at the upper secondary education level.

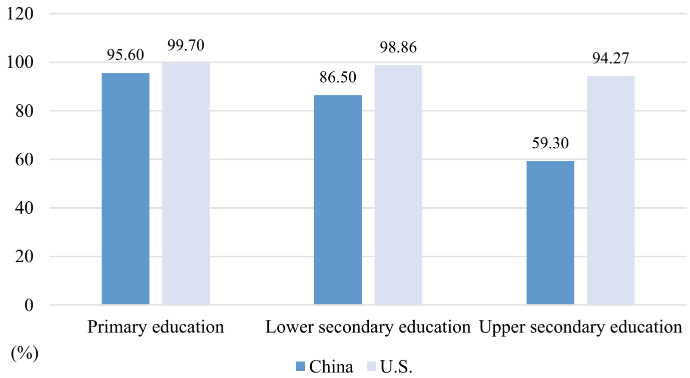

Fig. 12 Completion rates at basic education level (China and the U.S.) (%). *Sources* Adapted from UIS (2020)

2.3 ICT Resources

The information and communication technology (ICT) resources are a prerequisite for promoting innovative teaching and learning in the twenty-first century. The data in this section examine the ICT-related resources available in schools. With the prevalence of ICT-integrated teaching and learning in today's classrooms, particularly with the effect of the COVID-19 pandemic, ICT-facilitated teaching and learning has become widely used around the world.

Figure 13 compared China with Singapore and a group of high-income countries aligning with the World Bank's definition in terms of the percentage of schools with internet access for pedagogical purposes. It shows that most of the schools in China at all three education levels have provided access to the internet for teaching, which is above the average level of high-income countries. However, upper secondary schools are slightly less common to have internet access compared to elementary and lower secondary schools, the gap remains in terms of achieving universal internet access. All schools in Singapore have achieved internet access for teaching regardless of the education levels.

2.4 Student–Teacher Relationship

A positive student–teacher relationship is the cornerstone for a trust-oriented and supportive learning environment. School-aged children are likely to spend more time in schools with their teachers than with their parents. Thus, teachers play a key role in supporting students' learning and their mental and physical well-being. Evidence shows that a trust-oriented and supportive student–teacher relationship encourages

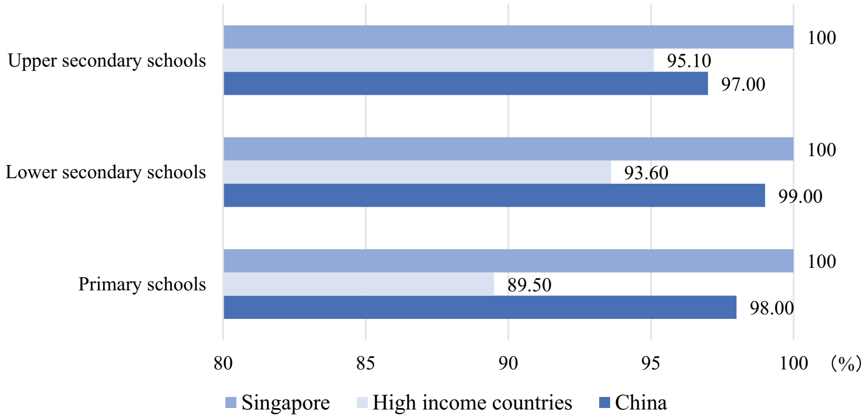

Fig. 13 Percentage of schools with Internet access for pedagogical purposes. *Sources* Adapted from UIS (2020) (%)

students to seek help from their teachers when they encounter intimidation, bullying and other difficulties (Konishi et al., 2010).

Figure 14 measures students' perception on to what extent teachers provide supports to students during the learning process. A large portion of Chinese students appear to have received support from their teachers, particularly, in their learning needs. Through the comparison with the OECD countries on average, Chinese students receive support from their teachers more often. However, as the data for China are restricted to developed regions, it is unclear to what extent the similar experience is shared by students across the entire China.

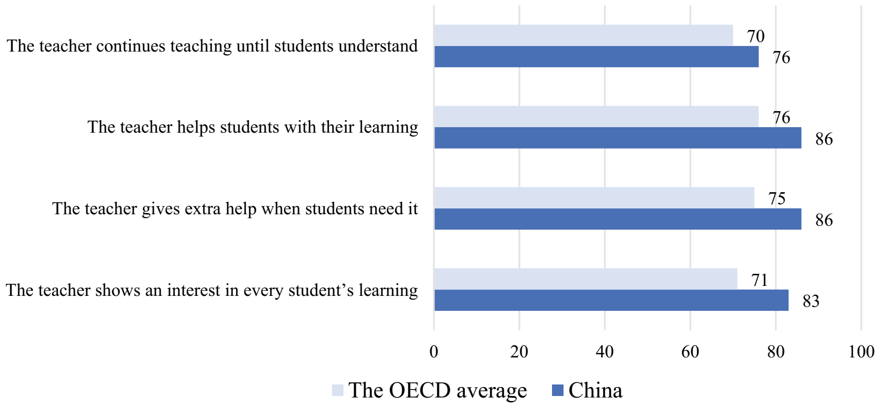

Fig. 14 Percentage of students who reported the following things happen in most or every lesson (%). *Source* OECD (2019a). *Notes* The data for China are restricted to four relatively developed regions (Beijing, Shanghai, Jiangsu, Zhejiang)

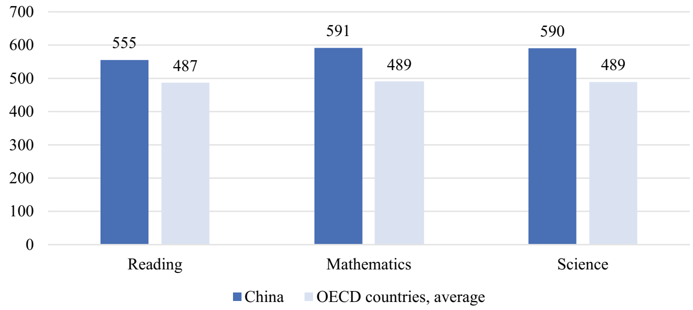

Fig. 15 Average performance in PISA 2018. *Source* OECD (2019a). *Notes* The data for China are restricted to four relatively developed regions (Beijing, Shanghai, Jiangsu, Zhejiang)

2.5 Students' Cognitive Outcomes

Equipping citizens with the knowledge and skills necessary to achieve their full potential contributes to an increasingly interconnected world, and ultimately converting skills they acquired in their lives, is the ultimate goal underpinning many education systems around the world. The Program for International Student Assessment (PISA) organized by the OECD to some extent reflects how effective countries are at achieving this goal. This section compares China's PISA performance in relation to other high performing countries, to better understand the productivity of China's education system.

As usual, PISA 2018 measured students' cognitive performance in reading, mathematics, and science. These three domains are considered the fundamental skills for students to strive in the twenty-first century world. Through the comparison, it is evident that Chinese students' performance is above the average level of OECD countries. The data also show that China has a remarkably large proportion of high-performing students and lower proportion of low-achievers than the OECD average, which indicates that the high performance of China in PISA is driven by a general excellence of its students and does not just rely on top-performers. It can be argued that China's education system has a high capacity to nurture excellence while also ensuring minimum standards. However, as the data are restricted to Beijing, Shanghai, Jiangsu, Zhejiang, this interpretation cannot be applied to all regions (Figs. 15 16 and 17).

2.6 Non-cognitive Outcomes

The above cognitive performance only represents one aspect of education success. It is increasingly important to realize that academic achievement alone is far from enough to capture the development of students and the quality of education systems. Many education reform frameworks have prioritized the development of students'

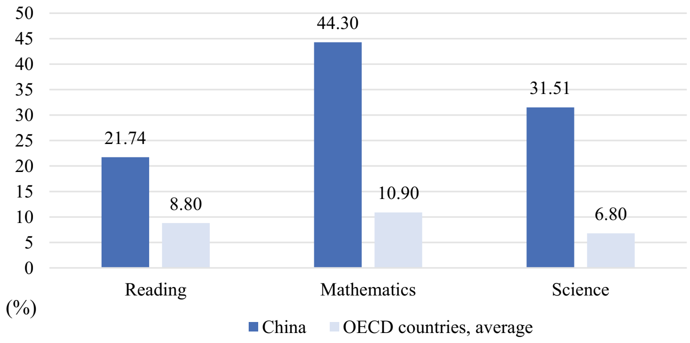

Fig. 16 Percentage of low performing students in PISA 2018 (%). *Source* OECD (2019a). *Notes* The data for China are restricted to four relatively developed regions (Beijing, Shanghai, Jiangsu, Zhejiang)

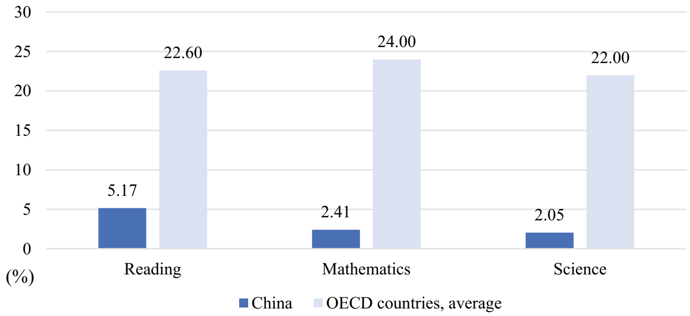

Fig. 17 Percentage of high performing students in PISA 2018 (%). *Source* OECD (2019a). *Notes* The data for China are restricted to four relatively developed regions (Beijing, Shanghai, Jiangsu, Zhejiang)

non-cognitive skills, such as social-emotional skills, mental well-being, physical well-being (e.g., China, Singapore, UNESCO, OECD). PISA 2015 and 2018 have assessed to some extent the non-cognitive aspects of student performance, which sheds lights into the efficacy of China's education system in promoting students' holistic development. Figure 18 presents students' motivation and attitudes towards competition and school-work related anxiety. A substantial body of research showed that students' motivation has explicit relation with students' academic performance, learning behaviors and mental well-being (Howard et al., 2021; Seifert, 2004; Thelk et al., 2009), which is a non-ignorable aspect of students' fundamental non-cognitive competencies.

Figure 18 shows how Chinese students feel motivated to achieve in their learning. About 80% of Chinese students agreed or strongly agreed with the statement "I want to be one of the best students in my class". Students in the U.S. also demonstrated a high motivation for excellence. Students' high motivation can have

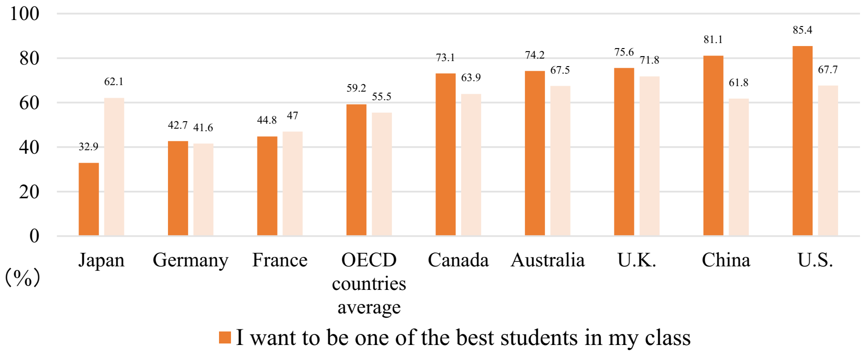

Fig. 18 Percentage of students who agreed or strongly agreed the following statements (%). *Source* OECD (2016). *Notes* The data for China are restricted to four relatively developed regions (Beijing, Shanghai, Jiangsu, Zhejiang)

nurturing effects on students' mental well-being, but when this motivation is driven by external pressure such as a high-stakes test, students are likely to experience mental-illness. It is observed that in many countries where students demonstrated a high achievement motivation, their students also tend to experience schoolwork-related anxiety. However, this does not seem to be the case in China. While many Chinese students demonstrated a very high achievement motivation, less students experienced a schoolwork-related anxiety such as feeling anxious even when they were well prepared for a test.

3 Excellence Indicators

This section intends to develop a set of indicators that provide insights into the performance of education systems. The excellence indicators include both quantitative and qualitative indicators across four dimensions: educational resources, national standards, education performance and outcomes. A comparative analysis was conducted by benchmarking the performance of China's education system against other global education systems. The goal is to explore a potential common ground for discussing the meaning and to enrich the concept of the excellence of the twenty-first century education systems.

This section comprises three key phases. The first section introduces the conceptual framework and methodology based on which the excellence indicators of the education systems are built. The second section presents an overall result of the excellence indicators of China and other selected countries. The third section taps into the key indicators of the excellence indicators to provide a more detailed interpretation of the data.

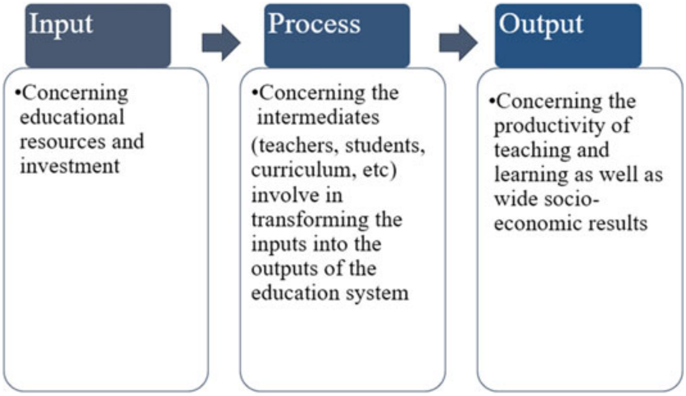

Fig. 19 IPO (input-process-output) model for education system

3.1 Design

The concept of an education system is a complex whole and contains a dynamic interplay of a wide range of factors from different dimensions. To categorize those factors and describe the education systems in a comparable manner, this chapter adopts the Input-Process-Output (IPO) model, which is widely used in system analysis to deconstruct the education system into key components and see whether those components work efficiently to achieve its goal (see Fig. 19).

Based on the IPO model, this chapter focuses on the key indicators measuring fundamental qualities of the three phrases of education systems. According to the guidance of the three theoretical phrases, the criteria used for selecting the indicators for this comparative exercise are based on:

- **Relevance and Comprehensiveness:** Indicators must be relevant to the themes of the 14 sub-dimensions outlined in the framework, which are chosen to cover each dimension from comprehensive perspectives.
- **Comparability:** Indicators must have comparable data across education systems, which can be collected through a valid and transparent methodology.
- **Coverage on China:** Indicators must have data on China's (or its subnational regions') education systems. If there are equivalent data from domestic data sources, the indicator is included.

3.2 Definitions and Sources

Table 2 explains the definition of the selected indicators. Five key indicators are selected concerning the input (resources) of the education systems. The indicators A1 and A2 examine the financial resources; the indicator A3 reflects the provision of education opportunities; and the indicator A4 and A5 concern about the teaching

Table 2 Selected excellence indicators on performance of education systems

Dimensions	Indicators
Resources	A1. Government expenditure on education as a percentage of GDP
	A2. Expenditure on education as a percentage of total government expenditure
	A3. Number of years of free education guaranteed in legal framework
	A4. Student–teacher ratio
	A5. Percentage of lower secondary teachers with bachelor's degree or above
Standards	B1. Administration of a nationally representative learning assessment
	B2. Frequencies of school inspection
Performance Outcome	C1. Children at the age of lower secondary education prepared for the future
	C2. Gross participation rate in tertiary education
	C3. Gross graduation ratio in tertiary education

forces in one education system. The dimensions of standard and performance are closely related to the process of one education system. For the dimension of standard, the two indicators are mainly centered on the question that how the process of education system is held accountable. Thus, the indicators B1 and B2 examine the education governance according to national standards. The dimension of performance provides a general view into students' cognitive performance at the compulsory education level. The dimension of outcome is captured by two indicators, which intend to reflect an overall picture of its effectiveness to accommodate students in its education system.

This comparative analysis focuses primarily on the existing evidence at the international level, and includes three strands of evidence: administrative data collected from major international organizations, international projects or surveys in which Chinese jurisdictions have participated, and data on China from national statistics.

For quantitative indicators, data are calculated for each country. The standardization method is used to standardize the highest value to 100 while the rest of values are scaled accordingly. After completing data standardization, the sum of the value of each indicator is calculated. Next, the highest value among the sum numbers is standardized to 100 whereas the rest of the values are scaled correspondingly. As a result of this process, the final excellence indicators are produced.

3.3 Findings

Excellence indicators attempt to provide a systematic comparison that reflects to some extent the quality of the education system. Through the calculation, the final finding shows that China's education has relative strengths in its education governance, however, improvement is still needed in terms of education resources, student performance, and education outcome. Australia and Singapore are the two leading education systems with little score difference in all education dimensions, ranking at the top in this comparison.

Among the selected education systems, China scores the lowest in the final excellence indicators. It is observed that China's education system demonstrates the strength in terms of education governance, by implementing a highly-structured national standard to regularly monitor the education quality. Different from the PISA test which only includes four Chinese regions, the excellence indicators selected in this chapter mostly represent China as a whole. Therefore, some indicators of China are not necessarily as remarkable as shown in the PISA study. For example, the student performance is lower when Chinese students are sampled as a whole, indicating there are noticeable differences of student performance across the Chinese provinces. This result contributes to the understanding of the overall quality of China's education system, and highlights the needs for China to continue its education reform for further improvement of its education system from a holistic perspective.

3.4 Discussions

3.4.1 National Investment in Its Education System (Indicator A1 and A2)

Financial resources are foundational to building a quality learning environment. The extent to which a country invests in education directly not only affects its citizens—affecting student enrollment, student school life and teachers' working conditions—but also profoundly enhances the productivity of a society, leading to long-term socio-economic benefits.

Indicators A1 and A2 focus on the financial resources available in the education systems. Indicator A1 shows government expenditure on education as a percentage of GDP, which provides a general look at how much of the national wealth is devoted to the education system and reflects the extent to which a government prioritizes its education as a function over the country's other functions. Indicator A2 measures the expenditure on education as a percentage of total government expenditure. It gives more focus on the extent of government commitment to provide quality education services to its citizens (Figs. 20 and 21).

3.4.2 Access to Basic Education Opportunities (Indicator A3)

The Article 13 of International Covenant on Economic, Social and Cultural Rights ensures the right to free education as the basic human right that every government should fulfill. The number of years of compulsory elementary and secondary education reflects, to some extent, the educational opportunities provided by the government, which is closely related to the equity and quality in education. Compulsory education means providing reasonable years of education to all people, which is

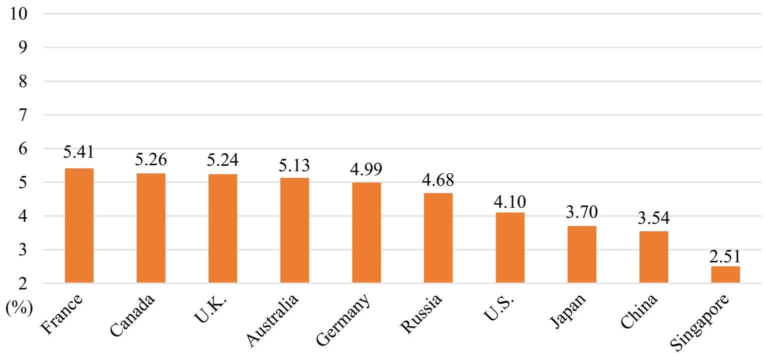

Fig. 20 Government expenditure on education as percentage of GDP (%). *Source* Adapted from UIS (2020)

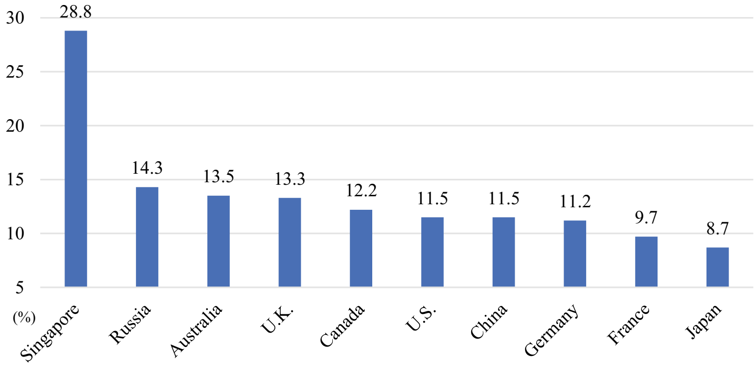

Fig. 21 Expenditure on education as a percentage of total government expenditure (%)

often protected by law. Nearly all the education systems around the world impose compulsory education on its citizens. The length of compulsory education can indicate minimal education services that a person is able to receive. Elementary education and secondary education lay the foundation for an individual to develop basic skills and competencies to live in the society. The indicator A3 examines the length of the compulsory elementary and secondary education guaranteed in the legal framework, which provides a look into the education opportunities available to all citizens (Fig. 22).

3.4.3 Teaching Workforce (Indicators A4 and A5)

The quality of an education system relies largely on the quality of teachers. Adequate supply and retention of highly qualified professional teachers are the prerequisites to

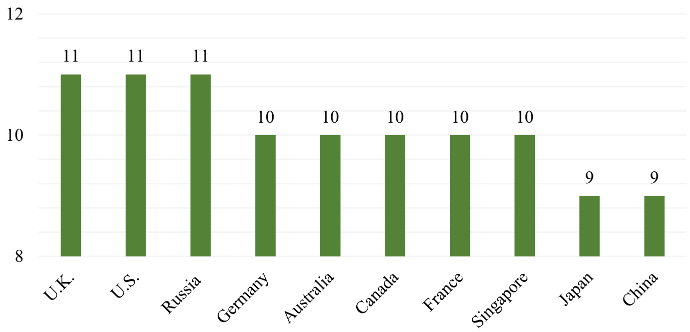

Fig. 22 Number of years of compulsory elementary and secondary education guaranteed in legal framework (%). *Source* Adapted from UIS (2020)

sustain quality learning opportunities through which students can receive trustworthy supports.

The indicators A4 and A5 primarily analyze the quantity and quality of the teaching workforce in the education system. Indicator A4 shows the number of students for every teacher, which provides insights into the adequacy of teachers and the workload that teachers may take in an education system. This indicator can reflect whether students in the education system can receive adequate supports from teachers. The higher the student–teacher ratio is, the lower the relative access of students to teachers is. Low student–teacher ratio tends to associate with students' greater academic achievement (Hattie, 2009). However, a lower student–teacher ratio does not necessarily mean a smaller class size. The distribution of teachers also influences the class size. In the indicator A4, Canada tends to have the highest student–teacher ratio, which suggests that teachers in Canada may work with more students than their colleagues in other compared education systems.

Indicator A5 examines the quality of the teaching force by calculating the proportion of teachers who have obtained the bachelor's or equivalent degrees above. This indicator calculates the percentage of teachers received a tertiary education at the lower secondary education level. The general assumption is that the higher education attainment can reflect to some extent teachers' quality. It is observed that at least 70% of teachers in all education systems have achieved bachelor's degree or above. Compared to other selected education systems, Chinese teachers' education attainment is relatively low (Fig. 23).

3.4.4 Accountability (Indicators B1 and B2)

A data-driven and robust accountability culture with adequate assessments can support countries in monitoring and evaluating the overall performance of their education systems, which further allows them to ensure that their education systems are developing towards achieving the overarching education goals.

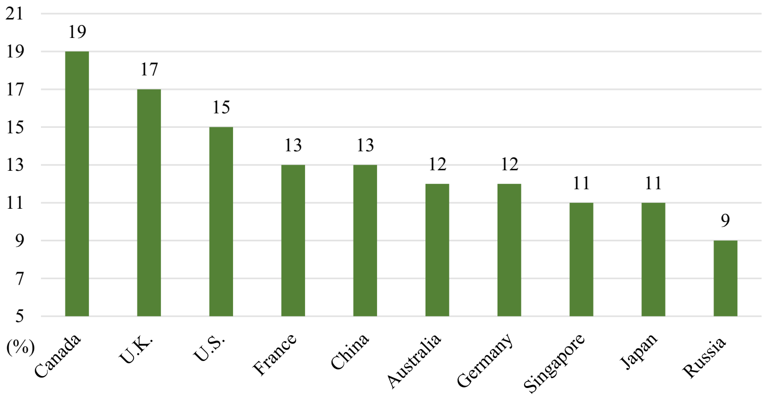

Fig. 23 Student–teacher ratio (secondary education). *Source* Adapted from UIS (2020)

Indicator B1 and B2 explore how education systems are held accountable by examining national policies and government standards. The indicator B1 examines whether there is a data-driven education governance infrastructure which regularly informs the government of the education system performance. This indicator evaluates whether a national or cross-national assessment of learning outcomes was conducted in the last five years in (a) reading, writing or language, and (b) mathematics at the following stages of education:

- in the Grade 2/3 in the elementary education.
- at the end of elementary education.
- at the end of secondary education.

This indicator examines the national standards for setting up a nationally representative learning assessment, which examines whether there is a system-level monitoring infrastructure in the education systems. The existence of such a practice shows that there is a national-level practice to monitor the performance of its education system. It is observed that most of the selected education systems have set up national learning assessments to collect information about the performance of their education systems. Such assessment typically takes place at the end of elementary education and the secondary education. Some education systems also conduct learning assessment in Grade 2 or Grade 3 at the primary education level.

Indicator B2 explores the accountability of education systems at the school level. It examines the frequencies of school inspection as regulated in its national standard. A clear regulation of school inspection suggests that there is a clear governance practice set up for holding school accountable. However, lacking regulation in the national standard does not necessarily mean there is no effort to ensure school accountability. It may be due to the decentralization of education governance in which school inspection is not required at the national level. School inspection is a common approach that is employed by many education systems to gain up-to-date information about school performance and to hold the schools accountable for students and parents.

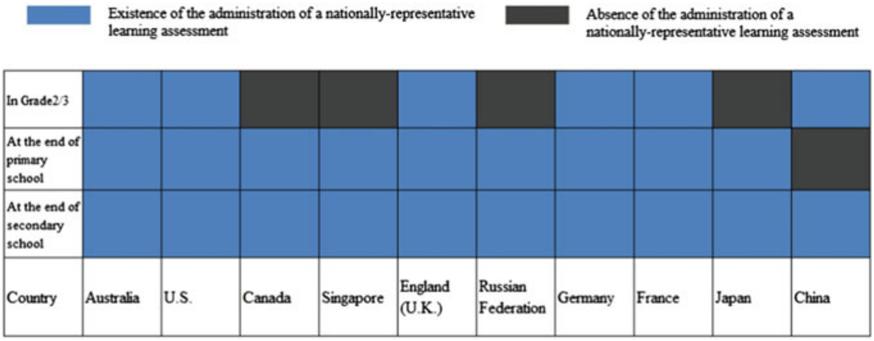

Fig. 24 Existence of a national learning assessment in education system

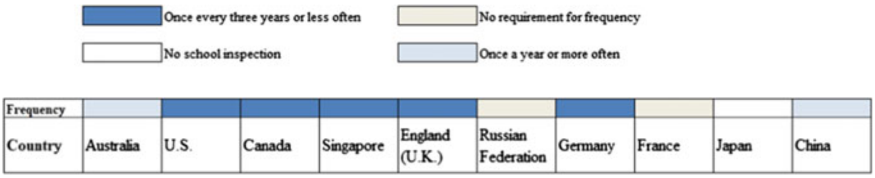

Fig. 25 The frequency of school inspection legitimatized in national policies

It is observed that many of the selected education systems conduct school inspection once every three years. China organizes annual inspections based upon national regulations/policies. Some education systems have no specific requirements for the frequency of school inspection, such as those of Russia and France (Figs. 24 and 25).

3.4.5 Student Cognitive Performance (Indicator C1)

Fostering students' cognitive performance is one of the crucial objectives of education systems. Comparing students' academic achievement on specific cognitive subjects provides an easy way to understand the performance across different education systems. Mathematics and reading are recognized as the basic subjects that are necessary for preparing the core competencies that students need for the future (OECD, 1999). Indicator C1 presents the proportion of lower secondary students who have reached the minimum proficiency level in the domain of mathematics and reading of the selected education systems. Specifically, this indicator measures the proportion of children within the ages of lower secondary education that have reached the minimum proficiency level in the domain of mathematics and reading. This indicator reflects the efficiency of the education system in terms of equipping its students with the necessary skills to strive for the future. A higher proportion suggests that the education system has a higher efficiency in preparing its students with the necessary cognitive skills. Around 70% of the lower secondary students in China have achieved

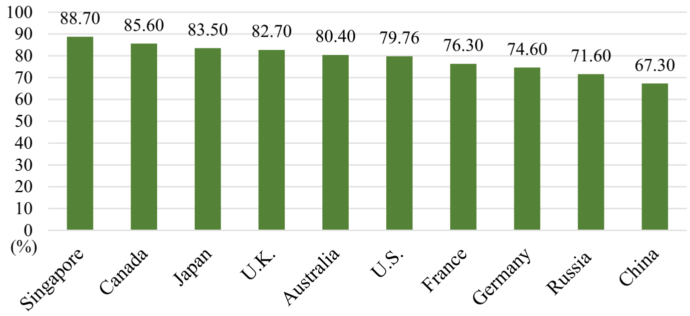

Fig. 26 Proportion of children at the age of lower secondary education prepared for the future (%). *Source* Adapted from UIS (2020)

the minimum proficiency required at the national level in mathematics and reading. A higher share is observed in many other education systems, among which, Singapore's education system prepares the highest percentage of students by equipping almost 90% of lower secondary education students with necessary mathematics and reading proficiency (Fig. 26).

3.4.6 General Performance (Indicator C2 and C3)

Whether students have adequate opportunity to advance from the basic education to the tertiary education is one of the important aspects that reflect the effectiveness of education system. Examining the enrollment and graduation ratio for tertiary education provides information on the proportion of students who succeed in moving all the way up to the tertiary education and eventually complete the tertiary education (Fig. 27 and 28).

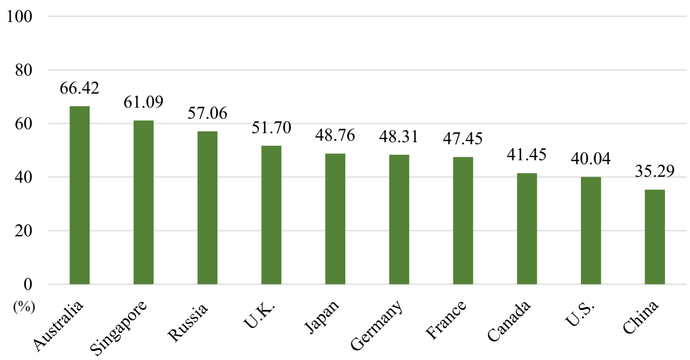

Fig. 27 Gross enrollment ratio for tertiary education (%). *Source* Adapted from UIS (2020)

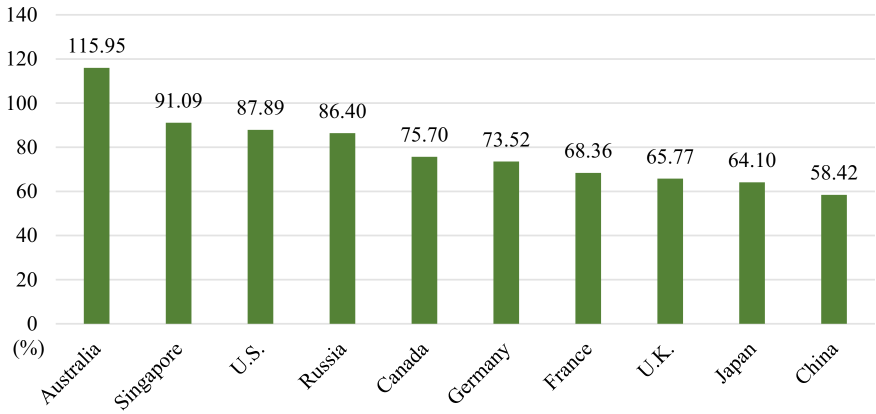

Fig. 28 Gross graduation ratio for tertiary education (%). *Source* Adapted from UIS (2020)

4 Best Practices

This section draws on influential education practices happening in contemporary China in the context of globalization. It focuses on China's practices on broadening children's access to basic education and international collaboration. This section starts with introducing the Project Hope (*Xiwang Gongcheng*), a non-profitable education project with far-reaching effects on China's education history. The analysis then compares the Project Hope with the global education movement "Education for All" and presents a full picture of how the international community works together towards ensuring every citizen has access to education. This section also highlights recent practices of how China has participated in global education development.

4.1 Sowing the Seeds of Hope to Children in Poverty

Students' universal access to basic education has improved tremendously in the past decades. Before the economic reform in the 1980s, education in China was still far from achieving the goal of universal access. In 1965, there were merely three million students enrolled in lower secondary education. Despite limited economic capacity, the Chinese government was committed to improving poor education conditions. In 1980, the government set the goal of universalizing elementary education by the end of the 1980s and universalizing the implementation of nine-year compulsory education in the 1990s. This commitment was further enhanced by the *Compulsory Education Law* published in 1986 (National People's Congress, 1986). It turns out that the Chinese government commitment to universalizing the basic education was not a pie in the sky. With continuous efforts through the decades, by the year of 2020, the participation in education in China has witnessed a remarkable increase. Taking the enrollment rate in the lower secondary education as an example, the rate soared to almost eight times what it was in 1965. Through this process, the government explored a set of effective policies and practices which allowed China to realize the goal of education universalization in a short period of time. One of the most up-lifting practices is Project Hope. The following content presents a sketch of this project and it is expected that these practices can shed lights into the progresses of education reform in contemporary China.

Project Hope is one of the most influential education charity events in China's non-governmental organization history. The primary aim of this project is to support children from poverty-stricken rural areas to complete the basic education. When the project was established, China was still a low-income country, facing a shortage of education fundings. Many children in poverty-stricken areas were not able to receive basic education. Statistics reported that more than 30 million children between the ages of 6 to 14 were unable to attend school or were forced to drop out. 84% of them were coming from the rural areas (China Youth University of Political Studies, 2010). Each year, there were one million children deprived of education because of poverty (Zhongguowang, 2004).

The Communist Youth League, a governmental body, and China Youth Development Foundation, a non-government organization, launched the Project Hope, with the overarching goal of ensuring that all Chinese children can enjoy the basic right to education. The project seeks to accomplish its goals through the following methods: setting up a grant-in-aid program to help drop-out students return to schools; building schools in poverty-stricken areas; providing teaching supports, pedagogical materials and textbooks; and providing special education funds for outstanding students in impoverished areas to go into tertiary education.

Project Hope has been a great success in China. Statistics show, by 2019, this project had received donations of US$2.16 billion dollars, which has helped millions of families and supported over 5.99 million students who had financial difficulties. A total of 20,195 elementary schools have been built, which continue to provide education to children in impoverished areas (Xinhua, 2019). The social influence of Project Hope is also remarkable. In 2010, a survey conducted by China Youth University of Political Studies showed that over 90% of Chinese citizens have "heard of" or "know in detail" about the Project Hope (China Youth University of Political Studies, 2010).

As it is one of earliest and the most successful non-profit movements in Chinese history, it has inspired an explosion of contribution in education by Chinese non-government organizations, which focuses on various pressing social issues, such as education, health care, environment (Ross, 2006; Stalley & Yang, 2006). A study surveyed over 1,500 project-sponsored students and found over 90% of them reported that this project has profoundly shaped their life values and raised their awareness to take part in public service activities (China Youth University of Political Studies, 2010).

4.2 Providing Education to Every Child

By the end of the twentieth century, the world had become increasingly integrated and globalized. It was in the dearth of building a sustainable development mechanism for the upcoming twenty-first century that education took on the responsibilities of preparing every citizen for work and life in a new era. However, by 1999, there was still a significant portion of uneducated population globally. In this context, the concept of "education for all" (EFA) emerged as the fundamental approach to guide the development of the global education reform. The right to education has been recognized as one of the basic human rights in the twenty-first century. The global community put forward the concept of education for all, which Hulme (2007) refers as the world's biggest promise in the form of the Millennium Development Goals (MDGs). In 2000, there are 189 countries and international partners devoted to promoting EFA in society. This section describes the main educational concept and ideology underpinning the global movement of Education for All, which aims to provide a global picture of education universalization which is similar to the process that took place in China.

EFA is a global movement led by UNESCO, aiming to achieve the basic right of education for every citizen in every society. This movement was officially announced through the Dakar Framework in 2000 at the World Education Forum in Senegal, Africa. 164 countries have participated and committed to fulfil the EFA goal by 2015 (UNESCO, 1996) including China. This global movement took place in a setting where children in many countries were not able to attend schools, millions of adults were illiterate, and one in three adult women in the world cannot read or write. Under this circumstance, the following seven goals of the EFA have been established:

- Expand early childhood care and education
- Provide free and compulsory elementary education for all
- Promote learning and life skills for young people and adults
- Increase adult literacy by 50 percent
- Achieve gender parity by 2005, gender equality by 2015
- Improve the quality of education
- Develop the Education for All Development Index (EDI) by UNESCO

With the development of EDI, the international community was able to monitor progress towards the above goals. As of 2015 there has been notable progress towards several goals. Students enrolled in pre-elementary education in 2012 have tripled when compared to 1999. The elementary education enrollment has jumped from 83% in 1999 to 93% in 2015. Participation in lower secondary education has increased sharply. Countries like China have seen the lower secondary gross enrollment ratio increased by at least 25 percentage points. Globally, the literacy rate has risen. More than two thirds of the countries have achieved the gender parity at the elementary education level. Many countries have raised their spending by at least one percentage point of national income (UNESCO, 2015).

However, the indicators also reveal that the political commitment for EFA has not been fully achieved and challenges still remain. Globally, one in four children still suffer from a chronic deficiency in essential nutrients. In sub-Saharan Africa, at least one in every five students could not complete the elementary education demonstrating that educational gaps continue to persist. In countries like Philippines, students from the poorest families have fewer opportunities than their economic-advantaged peers to participate in lower secondary education. Additional goal to increase adult literacy by 50 percent remains unachieved; and less than 75% of elementary school teachers have trained to meet national standards (UNESCO, 2015).

These indicators suggest that if the current trend of education development continues, the targets of the EFA will not be fulfilled in the future. This result also indicates the pressing need to uphold the international partnership for building continuous systematic supports for global education. Meanwhile, under the influence of the fast-evolving technology and the increasing uncertainty in the world economy and politics, exploring effective and innovative approaches and mechanisms is needed to help transfer the politic commitment into tangible support for education. Given this need, China has provided a few exemplary examples of international cooperation in promoting global education development.

4.3 South-South Cooperation in Education

South-South cooperation means the international cooperation among developing countries in the global South. The distinction between "North" and "South", rather than geographical location, refers to the social, economic and political differences that exist between developed countries (Global North) and developing countries (Global South). Traditionally, education cooperation often takes the form of North–South 333cooperation, through which the developed countries provide educational resources or other related supports to the less developed countries. However, as the North countries rarely share the same economic or political factors as the South and have rarely experienced the similar challenges in education systems as the South countries, the North–South cooperation may not accurately address the priorities and needs of the developing countries (Matos, 1999). South-South cooperation, therefore, is deemed as a complementary approach to international cooperation to facilitate knowledge, policies and knowledge sharing among developing countries (Gray & Gills, 2016). Evidence shows that Southern countries have contributed to more than half of the world's growth in recent years, and the outflow of foreign investment from Southern countries represents a third of the global flows. China is one of the Southern countries that is developing quickly in many domains and contributes to the overall global development.

For decades, China has long been on the beneficiary side from the North–South cooperation for education development. In recent decades, the education development in China has gradually drawn the world's attention. Since PISA began its world benchmarking efforts in 2003, China and its subregions have constantly scored as one of the best performing countries. Similar outstanding results were reported in the subsequent TALIS (Teaching and Learning International Survey). The project manager of TALIS, Karine Tremblay, remarked that many initiatives concerning teachers' professional development implemented in Shanghai, China, could serve as global model (Cao, 2017). With the increasing recognition of its education performance in the global community, China has actively engaged in international exchange and cooperation on educational affairs.

One of the noteworthy practices is the establishment of the UNESCO category II centers[2]in China, which shows China's initiatives in joining in the global network of international cooperation for education. Two category II centers have been established, taking into the advantages of educational resources of the local regions. The major functions of these centers are focused on knowledge production, capacity building, technical service and information sharing (UNESCO, 2022). Depending on the specific domains in education, the category II centers have strengths and serve for different purposes. The two centers in China are the Teacher Education Center in Shanghai and the International Center for Higher Education Innovation (ICHEI) in Shenzhen. Both centers have leveraged the advantages of the educational and other resources in Shanghai and Shenzhen, respectively. The following sections highlights the functions of the two centers.

4.3.1 Leveraging the ICT Capacity in Education Cooperation

ICHEI is based in Shenzhen, the city which is the home to many world-class leading technological enterprises such as Alibaba and Tencent. The Center has taken advantages of the city's resources, in combination with the strength of China's quickly expanding higher education system and the lessons learned from the advancement of the education innovation in the Asia–Pacific regions. Together, it promotes the use of the information and communication technologies (ICTs) in supporting higher education in developing countries. One of the seminal works produced by the center is the international institute of online education, which equips teachers with essential skills for online training and provides higher education institutions several ICT tools (UNESCO-ICHEI, 2022). This program has successfully built partnerships with dozens of higher education institutions in African and Asian countries.

4.3.2 International Cooperation on Teacher Professional Development

With the outstanding performance of its students in PISA and its teachers in TALIS studies, Shanghai has won the world's attention as one of the most high-performing education systems in the world. International research and studies, with attempts

[2] The UNESCO category II center is a privileged partner of the Organization with access to UNESCO's logo and international and intergovernmental bodies and networks, which independent of UNESCO.

to decipher the excellence of Shanghai education, have concluded that teachers are the most fundamental elements to the success of Shanghai students in PISA tests. The Teacher Education Center, which is another category II center under the auspices of UNESCO, was established under this background. It is in collaboration with Shanghai Normal University, a municipal-level university focusing on teacher training. The main purpose of this center is to be a service provider, standard setter, and a research and resource management center in the field of teacher education beyond the context of China. The functions of the center revolve around four perspectives: producing knowledge in teacher education; designing programs for teacher training; providing ICT supports to teacher education in underdeveloped countries; and sharing information with others UNESCO bodies (Cao, 2017). China's practices in South-South cooperation provide an example of how to leverage the local advantages and share resources to support the educational needs of other southern countries. As a result, this practice built a synergy for enriching the global knowledge and experiences for education development.

5 Inspiring Stories

This section presents two true and up-lifting stories that happened in the history of China's education: they focus on the inspiring individuals that have engaged in and made impressive contributions to China's education development. While this section tries to reflect Chinese education from an individual perspective, it also shares encouraging messages on promoting education development.

5.1 Su Mingjuan: Carrying Hope and Giving Back to the Community

In 1991, like many children who lived in rural China, Su Mingjuan struggled to gain opportunities to participate in education. She was a village girl born in a peasant family in a poverty-stricken village, situated in a remote mountainous area in Anhui, a province in central China. Although access to basic education was already guaranteed by law at that time, for families who lived below the poverty line, the additional burdens of paying fees for books and incidental expenses were out of reach for many families. This was also the case for Su.

Su's family could barely afford to pay RMB100 yuan (less than US$20 dollars) to send Su to the school. Su faced even further challenges when her father, her families primary bread winner, suffered injuries at work, forcing Su to withdraw from school. In this helpless moment, a turning point happened and changed Su's destiny.

A volunteer photographer from the Project Hope visited Su's village and tried to take photos of children and poor conditions of schools in the poverty-stricken areas, with the aim to raise the public awareness. This photographer saw shabby classrooms where there were no proper tables and chairs and their windows were without glass and only covered with thin paper. With a heavy heart, this photographer walked into one classroom and saw the children with worn clothes sitting on the benches staring back at him with curiosity.

Suddenly, his camera was attracted by a small girl, eight-year-old Su, holding a pencil that is short enough to hide in her palm. The photographer quickly clicked on the shutter and captured the moment. The photo of Su depicts the realities of many children in the poverty-stricken areas. The big eyes of Su depicted in the picture reflect the in-depth desire and hope of thousands of children for learning. Such emotions have passed on through this photo and reached the bottom of people's hearts.

With the attentions Su's picture brought to the Project Hope, it became well known and was able to fund more children in poverty. Because of the Project Hope, Su could go back to school and studied all the way to university. With her excellent academic performance, she has earned her degree and works in the bank in her hometown province.

As a girl living in remote mountain, Su who dropped out of school because of the poverty, was able to leave the mountains and achieve her life goals through the empowerment of education. Later on, Su decided to pay back to the society and help children who are also affected by the poverty. In 2018, Su has donated her savings and set up a student fund. She worked as a volunteer to help children with difficulties. Now, as an alumna of Project Hope, she is an active advocate for education. She actively engages in public welfare and charity with the hope of changing the destiny of more children who live in poverty.

5.2 Andreas Schleicher: Examining China's Education from an Outsider's Eyes

PISA is the most comprehensive worldwide international benchmarking study for education systems. It has profound impacts on global education reforms and shaped the rhetoric on teaching and learning in the twenty-first century. Andreas Schleicher is the man who initiated this revolutionary study. Andreas, a German researcher and the head of Education and Skills Directorate at OECD, has been recognized as the funder of the PISA. He has advocated throughout his life for evidence-based education policy making and believes that "PISA can help us to look beyond in the current education system" (Lin & Zhang, 2020) and promote global education reform.

When China started to participate in PISA and continuously became the top-ranking country in PISA. Andreas had received many inquiries from the public regarding the reliability of China's PISA results, as there was skepticism about China's outstanding performance. For instance, an American think-tank Brookings Institution posted an article named "PISA's China problem", which questioned how representative Shanghai's performance was for the entire country. The article criticized PISA's Shanghai results for deliberately hiding the results of poor students and poor schools in Shanghai (Loveless, 2013). As the first person responsible for PISA, Andreas has engaged in this debate with the Brookings Institute. His provocative response letter back was titled, "are the Chinese cheating in PISA or are we cheating ourselves?" Andreas's essay began by pointing out a disturbing phenomenon long existing in international medias.

> Whenever an American or European wins an Olympic gold medal, we cheer them as heroes. When a Chinese does, the first reflex seems to be that they must have been doping; or if that's taking it too far, that it must have resulted from inhumane training (Schleicher, 2013).

Although there are detailed technical note provided to justify the validity and reliability of Shanghai data published by OECD, Andreas was still surprised that many criticisms were groundless and did not even look at the official documents that already addressed their concerns. One of the major criticisms of PISA's China performance was the internal immigrant problem. International stereotype was that the house registration system in China restricted children from rural areas from gaining access to education in Shanghai. However, this was no longer the case. In fact, China had changed this policy long before opening up the education opportunities for immigrant children. When PISA 2012 was conducted, the coverage of immigrant children in Shanghai was the same as all other countries. This stereotype held by the international community is engendered from long-time misinformation.

Andreas accurately sensed this misunderstanding long existed between China and the West. As a researcher himself, he has always believed in empirical evidence over second-handed opinions. To better understand Shanghai and China's education systems, he visited China many times, going to local schools and observing China's education system through his own eyes. With the information he gained, Andreas developed more in-depth and critical insights into China's excellent academic results. One of the advantages featured in China's education system is the equity of learning despite students' backgrounds. He has observed that "the four provinces (Beijing, Shanghai, Jiangsu, and Zhejiang) tested in PISA have made teaching as a profession very attractive" (Edwards, 2019). He noticed and shared that Shanghai's system has the capacity to attract well-qualified teachers to top schools, which provides disadvantaged students at these schools a greater chance to accelerate their learning. According to his experiences in remote areas in Yunnan, Andreas observed that students there also received good-quality education. It was through close observation and fieldwork-based research that Andreas developed a more comprehensive and objective understanding of China's education systems, which allowed him to see both its strengths and deficits.

Academic achievement is one strength reflected in China's PISA results. However, Andreas pointed out that the non-cognitive skills of students in China and expressed concerns. Additionally, in the PISA 2018, Andreas pointed out that Chinese students showed less satisfaction with life compared to their peers in other OECD countries. Anyone who has experienced China's education systems would notice its competitive exam-oriented culture and Andreas observed this too. He further commented on the prevalent exam-oriented culture in China, saying that "the exam is just one of many ways to verify learning. It is about whether you can think like a scientist or mathematician, translate a real-world problem into a mathematical solving, interpret the result back in the problem context". When he was asked to give suggestions to Chinese education policymakers for the future education reform, he commented with a simple phrase "learn a little less for the exam, a little more for life" (Lin & Zhang, 2020). This story reflects the misunderstanding towards China's PISA performance in the global community. Rigorous research is needed to explore the Chinese education myth under the PISA statistics and reveal the mechanism of China's education. Only through this, can the PISA test bring more meaningful discussions for global education reform rather than just a simple comparison.

6 Latest Research

This section presents an outline of the existing literature on education system reform and development with focus given to Chinese contexts. Bibliometric analysis was used to map existing research on education systems. Quantitative results from the bibliometric analysis are presented, highlighting emerging themes and research trends. Finally, a comparison between Chinese literature and international literature in this domain is reviewed, providing recommendations and suggestions for future research.

6.1 General Overview

By collecting data from the China National Knowledge Infrastructure (CNKI) platform, a citation analysis is conducted for all Social Science Citation Index (SSCI) articles relevant to education systems. Articles are selected and screened based on the following criteria:

- Papers were published between 2012 and 2022;
- Article theme must be concerned with education system reform;
- Papers must be situated in the academic field of education research;
- Papers must relate to basic education, and tertiary education related articles are excluded
- Papers are published in academic journals indexed by PKU (Peking University Core journals) or CSSCI (Chinese Social Science Citation Index).

Through citation analysis, key sub-themes were identified (see Fig. 29).

A total of 10,690 published articles meeting the inclusion criteria have been identified. From 2012 to 2022, there have been a steady amount of academic research relevant to the topic of education system reform. Approximately 1,000 research articles have been published annually. The most commonly identified themes include

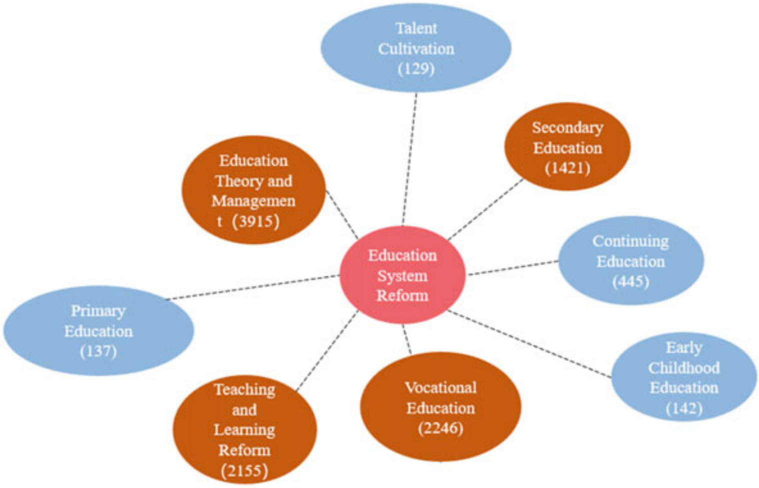

Fig. 29 The major themes emerged in the Chinese publications concerning education system reform and development. *Source* Compiled from search results from CNKI and CSSCI

education theory and management, vocational education, teaching and Learning reform, and secondary education. Four additional emerging themes are also found in the current Chinese literature, including continuing education, early childhood education, primary education, and talent cultivation.

By leveraging word cloud analysis of international literature indexed in Web of Science (WOS) social science citation index database, 20 frequently used keywords appeared in the themes of the selected literature for education system research. The majority of the current international research on education system research is centered on higher education, which matches the patterns shown in Chinese literature. In addition, distance education and teacher education also appear to be the popular research topics that attracted many researchers' attention. However, there is also a portion of literature devoted to international development topics such as inclusive education and sustainable development, which signifies the importance of a global perspective in the research of education systems. Noticeably, China's education system has drawn much attention of the international research community and emerged as a popular research topic. Two research designs appear most frequently, which include case studies and systematic reviews. These two research methods are also used widely by Chinese researchers. A case study is most often used by researchers to explore policy and best practices of education system reforms based on a comparative education analysis (Fig. 30).

Fig. 30 Word clustering analysis of the international articles published in a recent decade concerning education system indexed in SSCI (Social Science Citation Index). *Source* Compiled from search results from SSCI

6.2 Current Research Focus

6.2.1 Technology-Empowered Education Reform

This section highlights one of the broad themes emerged in the literature of the education system reform – technology empowered education reform. The use of technology has brought an innovative transformation to the traditional education system in the twenty-first century. Contemporary researchers in China have devoted a large amount of interests on this topic. According to different types and uses of technology in education, the literature on this topic can be summarized into three subthemes, that is, distance Education, education informatization, and AI-empowered education.

Distance Education. Distance education has emerged as one of the major themes relevant to education system research. The literature focuses on integrating technology into education and building an innovative education system, which disrupts the traditional monotonous form of education and explores a blended form of education design. Researchers explore the potential of using different technologies to design distance education system. Cui and his colleagues (2020) explored how to use VR live broadcast technology to design a distance education system that can improve teaching efficiency. Some researchers explored the use of Web, Java and other technologies in the design of a distance education system. There is also a portion of literature that seeks to construct new conceptual theories to guide the design of a technology-enhanced education system (e.g., Feng et al., 2013; Hu et al., 2019). The concept of life-long learning serves as the fundamental conceptualization in guiding researchers discussions on the rationale and methods of promoting distance education (Zhang, 2022). Literature regarding the distance education suggested a need for more evidence-based research and a need for enriching the general theories for distance education. Meanwhile, promoting blended learning and deep learning through a distance education system is a promising area for future research to explore (Tan & Xu, 2018).

Education Informatization in Education Systems. Another theme focuses on education informatization, which emphasizes the use of communication technologies to facilitate the innovative education reform. Education Informatization 2.0 has emerged as an attractive research topic among Chinese researchers. Education Informatization 2.0 is distinctive from education informatization 1.0 which mainly focuses on qualitative changes of technological software in school systems. The education information 2.0 focuses more on transformation and innovation of education systems empowered by informatization. For example, Chinese researchers discussed building an eco-system for teaching and learning with the integration of big data and artificial intelligence. Some conceptual suggestions on how to construct an effective education system in the era of education informatization 2.0 have also been explored (Hu & Zhang, 2018; Zhang & Liu, 2020). Equivalent to the term of education informatization, "smart education" is widely used to express the similar concept in Chinese literature. Many researchers study how to build smart education systems which enable effective teaching, personalized learning, and more supportive environment (Zheng, 2018; Zhu & Hu, 2022).

Artificial Intelligence (AI) Empowered Education System. With the growth of interest in technology empowered educational reform, Artificial Intelligence (AI) has attracted the interests of many researchers. Following UNESCO's first international meeting on AI in education in Beijing in 2019, there has been a blooming literature provided in-depth thoughts into how to build an AI empowered education system. Wu and his colleagues (2017) analyzed the current research outcomes in China by using word frequency and co-word analysis. Their research concluded that the AI education products developed by Chinese enterprises were the driving force for promoting AI empowered education reform. They further proposed a conceptual framework for an AI empowered education eco-system that encompassed the key consideration including the technical architecture, the application forms and the stakeholders. Some researchers tend to focus on AI for a specific education system, such as teacher education (Chen, 2019, 2019a, 2019b), or higher education (Li et al., 2021). Meanwhile, other researchers have adopted a comparative lens to examine best practices for the integration of AI in education systems, such as in Canada (2020), and the U.S. (Tian, 2021). Chinese literature in this domain focus principally on the technology transformation and regard it as a core driving power for the high-quality education system reform in the future.

6.2.2 Universal Access to Education

The education opportunities for students have been a core concern for Chinese policymakers and researchers. Literatures discussing China's education reform provide extensive insights into this question. One genre of policy-based research systematically analyzed the policies that Chinese government had conducted to promote education universalization. Fan and Fan (2022) pointed out that China's education reform for the past decades has been guided by a people-centered principle, which always upholds the interests of people. Many researchers paid particular attention to education reforms since the "opening-up" policy in 1980s, highlighting the changing priorities of government policies in promoting education universalization (Liu & Cheng, 2018; Qi & Yang, 2018). The unified development of urban and rural education has been regarded as an effective strategy that is worth to be continually upheld in China education reform.

Student access to upper secondary education is one of the most popular research areas when discussing Chinese education universalization. Many researchers highlighted the urgent need to improve the attractiveness and quality of vocational education at the upper secondary education level to achieve a well-balanced development of the education system (Li, 2015). Researcher analyzed education policies on vocational education and identified that current education reform goals are to promote the equal proportion of student enrollment in general learning and vocational learning tracks at the upper secondary education level (Li, 2021, 2021b). Improving the quality of rural education is another crucial priority for narrowing the educational gap and achieving universal access to education. Zhang (2012) identified a pattern from Chinese unique characteristics in the policies and practices carried out by the Chinese government from the past 60 years, which are still considered as meaningful for the future development of the rural education in China.

6.2.3 Education Equity

Ensuring the equity in education has been set as the fundamental principle for China's contemporary education reform. In the past several decades, the Chinese government has put forth the new policies and practices to develop an education system with high-quality and equity development. Relevant literatures have summarized the reform experiences for ensuring education equity in China's education history, arguing that the meaning of education equity has become more comprehensive and inclusive (Feng & Gao, 2022a, 2022b, 2022c, 2022d). With the age of globalization and informatization, the education ecosystem has been reconstructed. Researchers argued that the idea of education equity is shifting towards fulfilling the diverse learning needs of learners. This idea suggests the education system should be reformed in a way that allows for more seamless transitions of different learning tracks and pathways, so as to empower the learners to pursue individualized learning goal (Xu & Xie, 2022). In terms of policy implementation, some researchers focus on education governance in China and explore approaches to optimize the government's capacity to monitor the equity of public education services (Li et al., 2022). Zhou and Li (2022) discussed the potential pathways to conduct a systematic education reform, which viewed the public service, teacher education and lifelong education as an integrated approach to promote education equity.

How to leverage the benefits of the information technology to promote the education equity is a question that has received growing attention in recent years. Many researchers explore the mechanism (e.g., Han, 2021), the implementation strategies (e.g., Chen & Zhang, 2012) and the practical cases (e.g., Feng et al., 2020) of using technology for equity promotion in education. From a perspective of education governance, a country's education development is deemed as instrumental for the overall development of national education equity. Liu (2021) identified that the county education existed various forms of segregation and building county's government capacity to connect the resources and knowledge with outside was needed to overcome such segregation. In the urban area, the problems like shadow education are also considered harmful for education equity which has raised researchers' concerns. For example, Li (2020) analyzed the causal mechanism of shadow education problem through the lens of social science, putting forth specific strategies of how to prevent the extracurricular tutoring. In addition, some researchers highlight the problem of the high-stake test culture that has long existed in the Chinese education system and point out the need to reform such culture to better support the economically and socially disadvantaged students (Lu & Chu, 2017; Qi & Tang, 2016).

6.3 Research Trends

6.3.1 Leveraging the Benefits of Technology to Improve Underdeveloped Education Areas

Vocational education has long been an underdeveloped education area, which needs urgent intervention to improve its overall quality and attractiveness for students and their parents. With the growing acknowledgement of the benefits of using technology for empowering education system reforms, a growing number of researches study recent education reforms in vocational education. Exploring how to leverage the role of technology for improving the quality of vocational education has emerged as an identical trend in current Chinese academic research. Some researchers focused on the curriculum and pedagogical reforms enabled by the ICT-related technology (e.g., Gao, 2015; Yang, 2018) while other researchers focus on specific case studies to unearth the potential rules or principles for guiding technology used for improving vocational education (e.g., Chen, Y., 2019; Zhang et al., 2019). In addition to vocational education, other underdeveloped education areas including career education (e.g., Qi & Wang, 2021), entrepreneurship education (e.g., Wang, 2022), adult education (e.g., Feng & Cheng, 2020), have also emerged as relatively new focused areas in Chinese literatures discussing the role of technology in the process of education reform.

6.3.2 Increasing Focus on High-Quality Development to Strengthen Education Access

With the rapid development of universal access of compulsory education in China over the past decades, the needs of education reform gradually moved from broadening public access to compulsory education towards providing high-quality education services to the people. A growing number of researches have paid attentions to upper secondary education and extends the scope of education universalization beyond the compulsory education. While student enrollment in upper secondary education is booming in China, Chinese researchers identified a number of existing problems, such as shortages of qualified teachers, a widening gap in student performance, the governance challenges in large-scaled schools (e.g., Liu & He, 2016; Shi & Zhu, 2015). They explored the potential strategies for education reform, including a systematic reform approach that integrates teaching, assessment and recruitment (Sang & Xu, 2021); a comparative model guiding the distinctive reform between vocational and general learning tracks (Liu, 2020); and a potential solution to break the binary of vocational and general learning divisions (Chang, 2020). Likewise, research trends on the quality development in the process of education universalization also extend to the early childhood education stages. Researchers not only discussed the management (Hu, 2021), the curriculum (Li & Fan, 2020) and teaching methods (Wen, 2020) of the early childhood education reform, but also shed lights on early childhood education development in the rural areas and socially disadvantaged groups (Li, 2019).

6.3.3 Growing Emphasis on Building a Well-Balanced, Inclusive and Equitable Education System

During the past decades, education equity at the basic education level has improved dramatically in China. However, there are still many pressing issues endangering the quality of its basic education, such as students' academic burden, exam-oriented culture, and poor management of private education services (Xu, 2015). These real problems matter to the interests of all citizens, which urge Chinese researchers to conduct more in-depth research to explore the possible solutions. One emerging research trends concerns the modernization of the governance of education quality. Chinese researchers explore how to build an education governance infrastructure so that the quality of basic education can be monitored with scientifically methods (e.g., Tian et al., 2022; Li & Li, 2021, 2021b). Song and his colleagues (2021) proposed the idea of leveraging the benefits of big data to drive the reform of basic education evaluation. Such research focuses on data-driven governance is in line with the global education governance reform, which places values on evidence-based policymaking and management (Zheng & Yu, 2022). Another emerging trend in the research related to education equity is the focus on the policy agenda of alleviating students' homework burden ("Double Reduction" policy). Researchers started to discuss how to reshape the current academic oriented education system towards a more inclusive education that accommodates increasing diverse needs of learners, with the overall goal of achieving both high-quality development and the education equity (Fan, 2021; Dong & Li, 2022a, 2022b, 2022c, 2022d; Liu, 2022).

7 National Policies

This section introduces some innovative national Chinese educational policies. These policies reflect the trends of current education reforms that China's education systems are being shaped towards. The long-term goals depicted in these policies outline a blueprint for China's future education development, which shed lights on the future society and citizens that China aims to develop. This section highlights the latest education policies that are fundamental for international researchers to interpret China's education context.

7.1 Fundamental Policies on Education System Reform

Building a future-ready education system has long been a priority concern of the education reforms around the world. With a world facing rapid changes in technology and an increasing uncertainty of the global environment, how to prepare their citizens so that they can strive to live in an uncertain world appears to be a fundamental question when planning education reforms. Future education largely depends on the guidance of the national policies. China has oriented education reforms towards he modernization ever since its opening up in 1978. The overall goal of reforms is to ensure the equal participation of every child in education. During the past decades, the participation rate of Chinese children in compulsory education has soared. The goal of providing universal access to education has been achieved, from the perspective of participation rates. With economic growth, China is no longer a "poor country running big education" rather it is shifting towards a "great country building strong education" (Zhu, 2019). A strong education system requires more than just achieving universal participation rates. The following subsections introduce the latest national education policies carried out in China. These policies determine the directions of China's current education reforms and depict the outlines of future education and the competencies of future citizens in China. The following content introduces the fundamental and cutting-edged educational policies that lay a solid foundation for the education development in the twenty-first century.

7.1.1 Constructing a Supportive Learning Environment

China has dedicated to providing a supportive learning environment. Following are the typical policies demonstrating Chinese efforts in doing so.

Online Learning. Since 2000, China has launched the basic education informatization plan. With the growing recognition of technologies' roles in education, China's central government published a policy entitled *Guidelines on Strengthening the Construction and Application of Online Education and Teaching Resources in Elementary and Secondary Schools* (MOE et al., 2021). This policy proposed five crucial initiatives:

- Construct a multi-scaled online learning platform that coordinates national, provincial, municipal, county and school-level platform
- Develop high-quality online learning resources
- Make full use of the online learning platform in the education process
- Improve teachers' and students' information literacy
- Improve policy governance on informatization in education

Preventing School Bullying. To strength a healthy school climate and protect the physical safety of the students, MOE published *Provisions on the Protection of Minors by Schools* (MOE, 2021a), which lays out regulations to address the potential safety issues in schools, including establishing a special protection system to prevent school bullying, specifying the regulation to prevent, educate and intervene in school bullying, improving the prevention measures towards sexual harassment.

Controlling the Use of Mobile Devices. With the pervasion of the mobile devices, the disadvantages of using phones in student development and school management have also been observed. To prevent students from overusing mobile phones, *Notice on Strengthening the Management of Mobile Phones for Elementary and Secondary School Students* has been published (MOE, 2021b), which requires that students in elementary and secondary education shall not bring their personal phones to school. When students have an absolute need to bring the phone, parents' permission is required. Schools must set out detailed rules to control students' use of mobile phones. The cooperation between schools and families is needed to provide a consistent guidance for students to use mobile phone wisely.

Family Education. China's education policy further extends its scope to home education and sets a framework to regulate the home education environment. The new law on family education promotion was put in place in 2022 (National People's Congress, 2021), which is the first law in China's education history to provide a clear legal framework for family education. This law has outlined parents' role as the guardians for their children's education at home and emphasizes the guardians' responsibility to arrange the time for children's learning, entertaining and exercises. Reducing children's academic burden and protecting them from internet addiction is emphasized in this law.

7.1.2 Promoting Quality Teaching and Learning

Promoting quality teaching and learning is another goal China has always strived to achieve. The following are the typical policies demonstrating Chinese efforts in doing so.

Reducing the Academic Burden. To protect students' well-rounded development and promote students' mental health and well-being, China issued a policy aiming to reduce students' homework and extracurricular training on subjects like Chinese, math and English (the State Council, 2021). It is officially required that the intensity and length of the homework should be reduced for compulsory education students. Schools must improve the quality of homework and provide guidance for students' homework. Schools should consider extending the after-course tutoring services to meet the diverse learning needs of students. This policy also set out the regulation for private supplementary tutoring services out of schools. To enhance the quality of school-based tutoring service, the policy further lays out the concrete measures, such as expanding the teaching force, increasing the financial subsidies for teachers, and controlling the advertisement of the shadow education.

Improving Curriculum and Learning Materials. To enrich the reading contents for students and extend their reading activities, MOE published a regulation on management of students' extracurricular reading materials (MOE, 2021c). This regulation specifies the ban of commercial activities such as lectures, promotion or advertisement of any kind of extracurricular reading materials in schools. Furthermore, the requirement for regulating the curriculum for the extracurricular activities is also set out, and corresponding policies were published to provide a guiding framework for private institutions to design, use, self-censor and supervise their curriculum.

Reorienting the Purpose of Examinations in Compulsory Education. The high-stake examination culture has always been a hotly debated issue in Chinese education. The Ministry of Education has carried out interventions to tackle the negative effects of examinations in compulsory schools (The State Council, 2021). It requires that schools reduce the frequency of exams, standardize content, scientifically use examination data, develop formative assessment and enhance the quality monitoring of student learning. The national policy clearly requires that the first and second grades in the elementary education shall not conduct any pencil-and-paper exams; the third to sixth grades in elementary education shall only have one final exam. Secondary education is permitted to have mid-term exams however only the higher secondary entrance exam will be used for selecting or tracking students.

Promoting Evidence-Based Education Governance. An evidence-based governance infrastructure supports policymakers in monitoring the quality of education systematically and contributing to well-informed decision-making in education reforms. China's MOE initiated a national assessment plan to monitor basic education quality in 2015 (The State Council, 2015). Design of this assessment plan is closely aligned with China's long-standing goals of improving education quality. The plan

Table 3 Elements of China's national assessment plan to monitor basic education quality

Contents	Details
Targeted population	All students at Grade 4 and Grade 8
Sample strategy	Stratified sampling
Assessed subjects	Chinese, mathematics, science, physical education, arts, and moral education
Instruments	Paper and pencil test and questionnaire; fieldwork assessment
Scoring types	Performance grading (I, II, III, IV)
Timespan	Once every three years
Report types	National monitoring report; provincial monitoring report; basic data report

Source the State Council (2015)

outlines detailed information regarding the targeted populations, subjects, assessment contents, timespan, assessment instruments and report types, which serves as the blueprint to guide the implementation of the national assessment to monitor basic education quality in China (Table 3).

7.2 Current Policy Highlights: Building a Future-Ready Education System

7.2.1 Education Modernization 2035: Background

In 2019, China published its education blueprint for the next 15 years entitled *China Education Modernization 2035* (The State Council, 2019). It states eight key action areas for current education reform.

At the international level, China's education modernization plan is a response to the United Nations' sustainable development goal, "to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". This goal established by the international community has guided China's overall education policymaking and has been assimilated into the preparation of *China Education Modernization 2035*.

At the domestic level, China has witnessed rapid socio-economic development in the past decades. The Chinese government put forward the national strategy of achieving socialist modernization by the year of 2035. Constructing socialist modernization requires the support of a modernized education system. Chinese policymakers have realized the importance of reforming education to meet the needs of national development. As President Xi Jinping mentioned in his speech, "We must give priority to education, further reform in education, speed up its modernization, and develop education that people are satisfied with."

It is under both international and domestic contexts that *China Education Modernization 2035* has been created. Through past efforts, students' access to education has been largely enhanced. However, challenges still remain. For example, current education tracks (general/vocational programs) are unbalanced; an exam-oriented culture persists, and school autonomy is low. The current education system is still far from meeting the needs of the national development goal, which is to build a prosperous, strong, democratic, culturally advanced, harmonious and beautiful modern socialist country (Xi, 2017).

7.2.2 Key Concepts Underpinning 2035 Reforms

The fundamental theme underpinning *China Education Modernization 2035* is to build an education system that can prepare future-ready citizens through well-round development. There are eight key broad concepts are identified as the conceptual pillars in the document to guide the strategical planning—ethics as the priority of education, well-rounded development, people-orientation, lifelong learning, personalized teaching, integration of knowledge and practice, integrated development, and co-construction and sharing.

Under the guidance of the above conceptual ideas, the key developmental goals aimed to achieve by the year of 2035 include:

- Build an education system that provides life-long learning opportunities
- Achieve universal attendance in quality pre-school education
- Provide high quality and balanced compulsory education (Grade 1–9)
- Achieve maximum attendance in senior high school (Grade 10 – 12)
- Significantly improve vocational education
- Build a more competitive higher education system
- Provide adequate education for disabled children/youth
- Establish a new education governance system with participation from stakeholders across society

Given the current problems and challenges in today's education system, *China Education Modernization 2035* outlines ten key strategic action areas to be addressed through the following priorities:

- *Promote socialism with Chinese characteristics in the new era.*
- Achieve high quality education with world class and Chinese characteristics
- Promote high quality of education at all levels and equal access to basic public education
- Achieve universal and equitable access to basic public education services
- Build lifelong learning systems
- Provide training and innovation of first-class talents
- Build a high quality and innovative teaching force
- Accelerate educational reforms in the information age
- Create a new pattern of opening up education to the outside world

- Modernize the education governance system

7.2.3 Highlights in China's Education Modernization Reform

There are several noteworthy changes from the previous education reform that can be observed in *China Education Modernization 2035*. One major change is the emphasis on innovation across all education levels and domains. The word "innovation" has appeared 18 times in this document, which involves building students' innovative spirits and abilities, developing an innovative teaching force, enhancing higher education institutions' capacity for innovation, reinforcing research innovation, as well as innovating education governance system. In this plan, "innovation" is placed as the keyword that involves in many specific reform strategies.

The second notable trend appearing in the plan is the emphasis on educational cooperation and exchanges. With the continuous opening and development of "One Belt One Road" initiative, there is a growing need to promote educational cooperation and exchanges in China. Thus, this plan defines developing a new pattern for education cooperation and exchange as one of the top priorities in the country's reform.

Another change can be observed from the plan 2035 concerns the education investment. Education investment is the prerequisite for building a quality education system. However, in previous education policies, the minimum expenditure on education was never required by the Chinese government. This current plan clearly requires "raising the level of education input", including ensuring the national expenditure on education to be no less than 4% of the gross domestic products. At the same time, the government must ensure that the educational expenditure per student increases every year. Such a requirement reflects the strong determination of Chinese government to reform its education system and the financial security guaranteed to support the realization of the education modernization.

7.2.4 The Global Trend in Education Reform: An Example from OECD's Education 2030

As one of the influential international organizations, OECD is also actively involved in the global discussion of education reforms. In line with UNESCO's 2030 Framework for Action on Education, OECD launched a project namely *The Future of Education and Skills – Education 2030* (hereafter *Education 2030*) (OECD, 2019b) to provide the conceptual guidance for global education system reform. OECD believes that the rapidly changing world brings challenges but also opportunities to global education. To better leverage the opportunities emerging from the rapidly changing world, education systems should prepare learners for jobs that have not yet been created, for technologies that have yet been invented, and to solve problems that have not yet been anticipated. It is guided by this vision that *Education 2030* intends to provide an international common ground and shared space for education reform in the twenty-first century.

Based on the competence framework established for the PISA study, the Education 2030 project looks beyond the cognitive competencies (reading, mathematics, science), proposed a broader concept of "core foundations" that are necessary for individuals to lead a quality life towards future. The core foundations consist of:

- Cognitive foundations, which include literacy and numeracy, upon which digital literacy and data literacy can be built.
- Health foundations, including physical and mental health, and well-being;
- Social and emotional foundations, including moral and ethics.

Both China's *Education Modernization 2035* and OECD's *Education 2030* stress the above core foundations. However, it is notable that the Education 2030 project tends to propose a more specific range of competencies from the individual levels, whereas *China Education Modernization 2035* includes similar concepts of core foundations inexplicitly in its text under the general themes such as "foster well-rounded development of citizens". The physical development of citizens is treated as equally important as intellectual development in this plan. However, developing learners' digital and data literacy seems to be less emphasized in China's *Education Modernization 2035* (Table 4).

It is based on the above core foundations that one individual can develop a higher-level competency, according to OECD. The Education 2030 project proposed a set of transformative competencies that a future-ready education system ought to nurture:

- *Create New Value.* By fostering student capacity for creating new value requires an orchestration of a number of qualities, including critical thinking, creativity, adaptability, an open mindset, collaboration, agility, risk management, curiosity and a sense of purpose.
- Reconcile Tensions and Dilemmas. Some key qualities that shape an individual's ability to reconcile tensions and dilemmas can be cognitive flexibility, perspective-taking skills, empathy, respect, creativity, problem-solving skills, conflict resolution, resilience and tolerance for complexity and ambiguity, and responsibility.

Table 4 Comparison of Education 2030-OECD and China Education Modernization 2035

Education 2030-OECD	China Education Modernization 2035
Cognitive foundations, which include literacy and numeracy, upon which digital literacy and data literacy can be built	Not direct addressed
Health foundations, including physical and mental health, and well-being	Enhance the physical education; establish standards of physical health at basic education levels
Social and emotional foundations, including moral and ethics	Improve students' moral and ethical quality; foster well-rounded development of citizens

- Take Responsibility and Consider the Consequences of Their Actions. Individuals should think reflectively and critically about the context and situation, the environment and society; have a sense of integrity, compassion, respect and willingness to trust others and society; and should develop self-awareness, self-regulation and locus of control to manage their emotions and behaviors.

The idea of transformative competencies featured by the OECD can also be found in China's *Education Modernization 2035*. For example, China's 2035 plan emphasized the same concept of creating new values. It proposes that the "curriculum needs to be reformed to foster students' innovative sprits and practical abilities". However, the China's plan does not provide an explicit concept of transformative competencies.

Another major difference that can be identified from the two future-oriented education policies, is their stances. China's *Education Modernization 2035* focuses on the systematic changes across all education levels. Therefore, the plan gives primary attention to the education system reforms. Whereas, OECD's Education 2030 project takes a stance from individual development, meaning the whole conceptualization is centered on human development rather than the education system. Focusing more on individual development, OECD 2030 project can guide the thinking of what kind of education systems needs to be built. It might be important for China's education modernization reform to refer to international experiences and ideas (such as the Education 2030 project), as this could effectively leverage the best policies and practices of education reform and meanwhile facilitate the educational exchanges and cooperation.

8 Summary

With the rapid development of education in China, which is evidenced by its remarkable performance in several international empirical assessments, knowledge about China's education system is important to enrich the global discussion of building the twenty-first century high-performing education system. This chapter provides a comparative review of China's education systems, primarily focused on its basic education level. The general performance of China's education system is benchmarked against several education systems around the world based on the comparative evidence collected by the reliable international databases and domestic sources. The intention is to display a more comprehensive picture of China's education systems rather than just the academic performance of students. Meanwhile, to compare the quality of its education system with the other major world education systems from a more holistic perspective.

The introduction presented how the Chinese education system differs from other major education systems around the world. China adopted nine-year universal compulsory education that covers the elementary education and lower secondary education levels. Learning tracks diverge into the vocational learning and academic learning tracks after lower secondary education. The diversification of the learning tracks has advantages in terms of offering students more fruitful learning opportunities. Some countries like Germany, tend to promote the diversification of the learning track at the early stage, which contributes to a robust vocational education system that effectively prepares a high-quality national skilled labor force. However, from a social reproduction perspective, a clear diversion of vocational education at an early stage may be at risk of diverting working-class students from higher education which perpetuates social segregation (Shavit & Muller, 2000). Providing students and their parents adequate education and career guidance is key to avoid such risks. Some education systems (e.g., the U.K., the U.S.) proposed a post-secondary education before the tertiary education to provide students a more targeted support, which can prepare students for a more in-depth knowledge acquisition, a chance to smoothly transform into work-life or a preparation into a tertiary education examination.

In the Highlighting Data section, key indicators that reflect the performance of China's education system were introduced. The participation rate of Chinese students in compulsory education is worth mentioning. It shows the improvement of education equity in China in the past decades. Student participation rates are catching up with many education systems in the developed countries at elementary education and lower secondary education levels. However, upper secondary education participation still lags behind. Regarding the ICT resources available in the education system, Chinese teachers and students tend to enjoy pervasive access to ICT resources. The overall student and teacher relationship is positive, Chinese students perceive their teachers to be very supportive of their learning. Based upon indicators of the productivity of China's education system, Chinese students demonstrated a higher excellence in the core cognitive domains, including reading, math and science than the OECD average. Furthermore, through comparing the proportion of high achievers and low achievers between China and OECD average, student performance is not merely driven by the top-performers, but also relies on the universal success of most students.

The Excellence Indicators section provides a systematic comparison that reflects to some extent the quality of the education system. Ten indicators are in the end selected which collected information on the financial resources, human resources, education opportunities, education governance, student performance and overall outcomes. Among the selected education systems, China scored the lowest on the final calculation of the excellence indicators. It is observed that China's education system demonstrates strength in the education governance, which implements a highly structured national standard to regularly monitor education quality. Different from the PISA test, which only covers four Chinese regions, the indicators selected in this chapter represent China as a whole. Therefore, some indicators of China are not necessarily as remarkable as shown in the PISA study. For example, student performance is lower when Chinese students are sampled as a whole. This result contributes to the understanding of the overall quality of China's education system and highlights the needs for China to continue its education reform for the further improvement of its education system from a holistic perspective.

The Best Practices section describes national practices implemented in China's education system, which illustrate the rapid development of the education participation at the basic education level in China. The Project Hope is a far-reaching practice in China's education history that contributes profoundly to support economic-disadvantaged children complete schooling. This national initiative resonates with the wide global movement EFA, which provides millions of children around the world the access to education. China is one of the key participating countries that contribute to the overarching goal of the education for all movement. In recent years, China has become actively participated into the global cooperation on education affairs. The ICHEI and The Teacher Education Center built in China, both take advantages of the cities' resources and support the education development in the underdeveloped countries. The inspiring stories in this chapter introduced some influential figures who have contributed profoundly to the contemporary development of China's education systems, and whose works and practices have inspired many educators, researchers and policy makers in China and in the world.

The Latest Research section summarized the key themes and trends in the existing Chinese literature on researching the topics of education system. Technology integration in education systems is another popular research topic. Chinese researchers have devoted attentions to distance education, informatization in education and AI empowered education systems, and tend to recognize the technology transformation as the driving force for education system reform. Other topics, such as talent cultivation, education reform and teacher education, have also drawn Chinese researchers' interests. Compared with the international literatures, some topics are found also attractive to international researchers, such as higher education, distance education and teacher education. Education systems for early childhood education and for sustainable development are the two emerging themes in the international literatures, which are still under-explored in Chinese academia.

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Chapter 9
Global Comparison of STEM Education

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Abstract STEM education is closely related to national development strategies, attracting attention from most countries and regions. With 30 years of development, STEM education has been implemented in K-16 educational systems around the world. This chapter briefly presents the development of STEM education in China at both secondary and tertiary levels. Chapter sections include highlighting data, relevant national policies, and latest research. This chapter also proposes excellence indicators for STEM education and applies them to measure the performances of STEM education in 10 selected countries. The best practices and inspiring stories sections share the Chinese experience of tackling the global challenge of attracting young talented researchers. It shows that secondary STEM education focuses on integrating new technology with maker education and actively utilizes new media and intelligent technology. Meanwhile, university STEM programs encourage young researchers to engage in innovative STEM research.

Keywords STEM education · STEM graduates · STEM talents development · STEM education policies · STEM research literature

1 Introduction

Science, Technology, Engineering, and Math (STEM) education was first initiated by National Science Foundation (NSF) in the United States (U.S.) in 1986, aiming to develop a highly skilled science and technology workforce. With the fast development of technology, STEM professionals are needed in many fields that support national

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economic prosperity, including emerging industries such as electric-vehicle production (Bakhshi et al., 2017). According to the *STEM Designated Degree Program List* issued by the U.S. Immigration and Customs Enforcement in 2016, engineering, biological science, math, and physics are listed as STEM disciplines. This list includes 91 sub-disciplines and 251 majors (U.S. Immigration and Customs Enforcement, 2016). There are 220 STEM majors focusing on research innovation and technology development, which represent physics, chemistry, biology and agricultural science. A noteworthy 44.2% of the 52 disciplines classified by the U.S. Department of Education have STEM majors. Research has found evidence of the positive effects that investment in STEM skills and research and development (R&D) have on GDP per capita (Bacovic et al., 2022). According to International Labor Organization (2020), STEM occupations make up less than 20% of employment in the 69 selected countries, ranging from nearly zero in several African countries to 15% in the U.S. and the United Kingdom (U.K.), and 17% in Austria. Research on STEM talents in various countries and economies still underscore the intense and urgent competition for talents in STEM. For example, the European Center for the Development of Vocational Training (CEDEFOP) predicted a significant skill shortage in STEM fields in E.U. countries in 2016 (CEDEFOP, 2016). In 2020, EngineeringUK published the report *Educational Pathways into Engineering*, which anticipated that the U.K. would suffer from severe competition for STEM talent in the next five years (Armitage et al., 2020). In response to talent shortages and the global competition, STEM education has been implemented in most countries, following the U.S. model. For example, the European Union (EU) promoted STEM education across countries and regions (European Commission, 2015a). 55 universities from 31 EU countries jointly launched the "Opening up Education" initiative and released STEM open-source curriculum to boost students' STEM literacy (European Commission, 2015b). Australia conducted a comparative study of STEM education development in 2013 (Dobson, 2013) and then released the National STEM School Education Strategy 2016–2026 (Australian government, 2015).

The global focus of STEM education has extended across educational levels and the meaning of STEM education has expanded. For example, the U.S. Department of Defense announced the Defense Science, Technology, Engineering, and Mathematics Education Consortium Cooperative Agreement in 2019 to strengthen K-16 STEM education and outreach efforts.[1] With accumulated practices and experiences in different countries, the goals of STEM education have become more diverse (Li et al., 2020a, 2020b). For example, STEM education includes both the individual disciplines of STEM (i.e., science education, technology education, engineering education, and math education) and interdisciplinary and multidisciplinary programs (Honey et al., 2014; Kelley & Knowles, 2016). Integrated STEM education is embraced by elementary and middle schools and reflected in education reforms in both U.S. (Tanenbaum, 2016) and China (Hu et al., 2017). It is

[1] https://www.defense.gov/News/Releases/Release/Article/1815911/dod-announces-award-for-stem-education-and-outreach-efforts/.

also expected to improve students' problem-solving skills and implement interdisciplinary learning in class (Johnson et al., 2015). The STEM education movement has increased project-based and problem-based learning across disciplines in K-12 education. Moreover, STEAM education was initiated by Yakmen (2006) and further developed in in Europe (Clarke, 2019) and Australia (Harris & De Bruin, 2017) to focus on creativity and critical thinking in learning. "STEM + ARTS = STEAM" was released by Culture Learning Alliance[2] in the U.K. in 2014, emphasizing the demand for fostering students' problem solving and innovation skills. However, Aguilera and Ortiz-Revilla (2021) conducted a systematic review of STEM/STEAM literature and questions the justification of replacing STEAM for STEM in fostering students' creativity.

The STEM movement spread to China around 2015. The first national survey of STEM education, *Chinese STEM Education Research Report*, was published in 2019 by STEM Education Research Center of National Institute of Education Sciences (NIES). The report showed that even definitions of STEM education vary according to different scholars, whereas cultivating students' creativity and practical competence are widely agreed on NIES (2019). STEM talents must be equipped with basic disciplinary competencies, innovation ability, STEM literacy, and teamwork skills (Zheng & Zhang, 2018). The report points out that, STEM literacy is performed mainly in science, technology, engineering, and math disciplines. Instead of simply combining the four subjects together, STEM literacy requires people to utilize science, technology, engineering, and math knowledge comprehensively in practice to identify and solve authentic problems, to create new technologies and products to deliver more benefits for human beings. In recent years, with the innovative utilization of modern technologies such as manufacturing technology, information technology, and computer technology applied in education, many elementary and middle schools in China have carried out STEM activities such as learning with robotics, 3D printing, and maker education. Nevertheless, due to the lack of systematic structures and effective strategies, STEM education in China still faces challenges in subject integration, teaching innovation, teacher development, and effective evaluation. (NIES, 2019).

The development of the STEM education in China and the world focus on developing a diverse STEM-educated workforce to further strengthen national prosperity and competitiveness (National Science Board, 2022). The analysis in this chapter focuses on STEM workforce development and uses the term STEAM education interchangeably. This chapter first compares STEM education development in different countries. Given the accessibility and international comparability of data, a set of STEM excellence indicators are developed to analyze and assess STEM education in 10 countries, including eight OECD countries: the U.S., the U.K., Germany, France, the Netherlands, Japan, the Republic of Korea (ROK), and Australia, as well as two emerging economies, China and Russia. The chapter also sheds light on Best Practices, Inspiring Stories, Latest Research, and National Policies of STEM education

[2] https://www.culturallearningalliance.org.uk/.

in China. This chapter intends to enrich the literature on STEM education in China, and highlights the global challenges facing STEM education.

2 Highlighting Data

This section reviews data and information on STEM education in China and provides a comparative analysis of China and counterpart countries. To capture the overall development of STEM education at both secondary and tertiary levels, the middle school students' academic performance in the STEM subjects, learning time invested, and STEM teachers' educational background, as well as the scale of bachelor's degrees awarded in STEM disciplines are presented.

2.1 Junior Students' Math and Science Performance in PISA

Achieving competence in math and science during elementary and secondary education prepares students to obtain post-secondary STEM degrees and STEM jobs (NSB, 2010), which in turn is conducive to national economic prosperity. This section analyzes 15-year-old students' math and science performance for 10 different countries based on OECD's Program for International Student Assessment (PISA) tests.

2.1.1 Math

In PISA, mathematical literacy refers to the ability of an individual to identify and understand the role of math in the world, to make informed mathematical judgments, and to use and engage in mathematical activities to meet the needs of one's life as a concerned, thoughtful citizen. China ranked first in terms of mathematical literacy in 2009 and 2012. Nevertheless, in 2015, Chinese students slipped to 6th place, lagging behind Singapore and Japan. In 2018, Chinese students surpassed Japanese students and once again became top-ranked in the world. As shown in Fig. 1, the math scores of students in China's participating regions in 2018 presented significant improvement over 2015, while the other countries did not show significant changes. Three Asian countries, China, Japan and ROK showed advantages in math; the Netherlands led European countries, while the U.S. lagged behind.

2.1.2 Science

In modern society, it is of vital importance for students to understand science and technology's roles in leading both individuals lives and public decision-making.

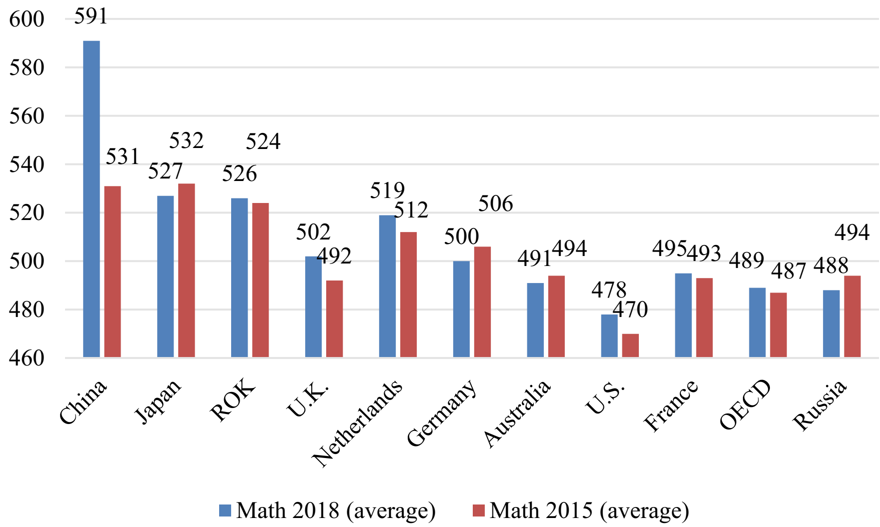

Fig. 1 PISA math results. *Source* OECD (2016a, 2019a)

Scientific literacy thus serves as an essential quality for young people today when entering the workforce. PISA's assessment of scientific literacy reflects the extent to which 15-year-old students master lifelong learning ability in science when they finish their compulsory education. In 2009 and 2012, the average score of Shanghai students ranked 1st in scientific literacy among all participating countries and regions. However, in 2015, China was behind Japan and other countries. China overtook Japan and led the group again in 2018. The performance of Japan, Australia, and Russia all dropped slightly. Among the 10 countries, Russian students under-performed in science (Fig. 2).

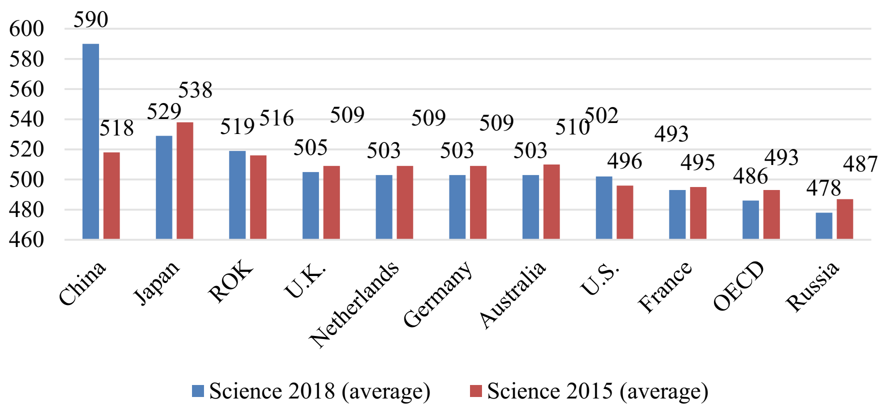

Fig. 2 PISA science results. *Source* OECD (2016a, 2019a)

2.2 Junior Students' Learning Time Invested in STEM

Along with the outstanding results achieved by Chinese junior students in math and science, they also spent significantly more time on learning. According to PISA 2018, Chinese junior students spent much more time on learning comparted to students in other countries. In particular, students with Level 1 proficiency in math spent 6.10 h in math learning every week, and the numbers were 6.22, 6.54, 6.98, 7.13, 6.82 for students in levels 2, through 6 respectively. Learning time is much higher than Japanese counterparts correspondingly (4.06, 4.26, 4.64, 5.06, 5.40 and 5.61), and that of OECD average (see Fig. 3).

Chinese students invested much more time in science learning and even more time in math. As is shown in Fig. 4, students at Level 1 spend 5.20 h on science learning, and the number are 5.22, 6.17, 7.76, 8.96 and 9.35 respectively for those students in Level 2, through 6. Comparatively, Russian junior students rank 2nd in learning time, level 5 students spend less time than the level 4 Chinese counterparts. And Level 1 Chinese students spend more time on science learning than that of level 6 in OECD countries, which is much higher than that of the U.S., ROK, Japan, France and Australia, etc.

The data above measure only the time of junior students spend in school, excluding after-school activities. However, excessive study tasks and extra tutorial services in China heavily affect students' mental and physical health. Under such context, Chinese government issued a series of guidelines to ease the burden of excessive homework and off-campus tutoring for students undergoing compulsory education, endeavoring to elevate schools' education teaching and service performance, and to

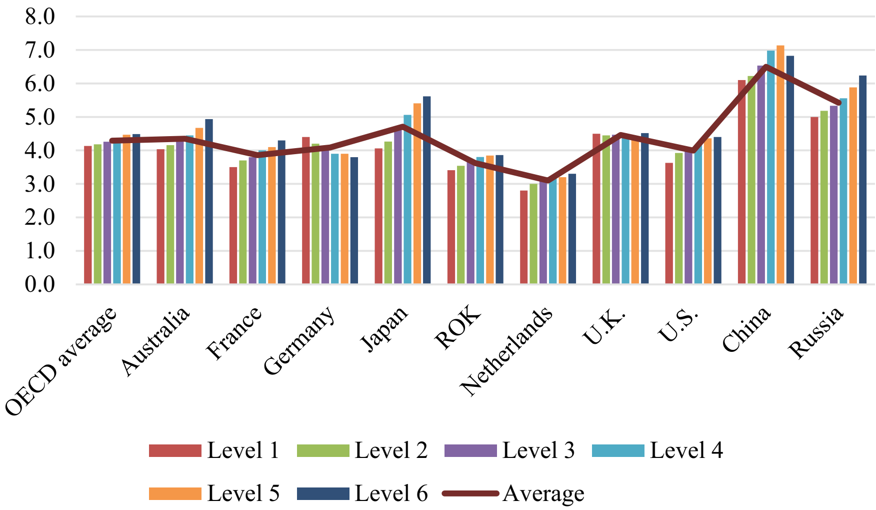

Fig. 3 Average number of class periods in math, by PISA math proficiency levels and jurisdiction (2018). *Source* OECD (2018a)

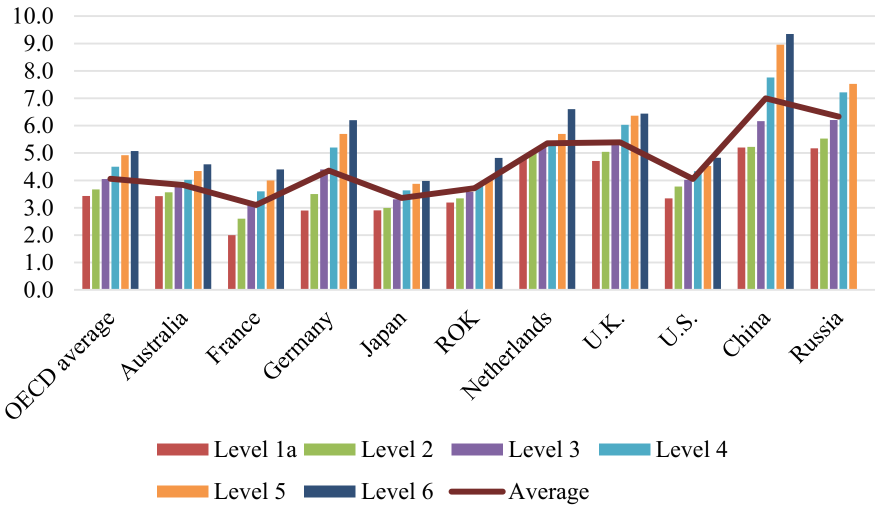

Fig. 4 Average number class periods in science, by PISA science proficiency levels and jurisdiction: 2018. *Source* OECD (2018a)

reduce the burden of homework and off-campus tutoring, thereby also reducing related household education cost and parent burdens (the State Council, 2021). However, the effect of this policy remains to be seen.

2.3 Educational Background of STEM Teachers in Junior High Schools

Teachers play a crucial role in students' learning. The majority of math teachers in junior high schools in China hold a bachelor's degree. In 2020, for example, 561,551 math teachers (85.64%) held undergraduate degrees, while 21,872 (3.33%) held master's or higher degrees. However, it is evident that an increasing number of teachers held postgraduate degrees (see Fig. 5). The data of science teachers show a similar profile in China, however, the percentage of science teachers holding master's degrees or higher degrees is 4.03%, about 0.7% higher than that of math teachers.

The Teaching and Learning International Survey (TALIS) provides information on international teacher education backgrounds at junior high school level (Grade 7–9). Math teachers with master's or higher degrees in OECD countries averaged for 47% and 52% for the U.S. For science teachers, 52% hold master's or higher degrees in OECD and 84% in France. (National Center for Science & Engineering Statistics, 2018). By contrast, fewer than 5% of math and science teachers in China had master's or higher degrees in 2020 (see Fig. 6) (MOE, 2020a). There is a significant gap

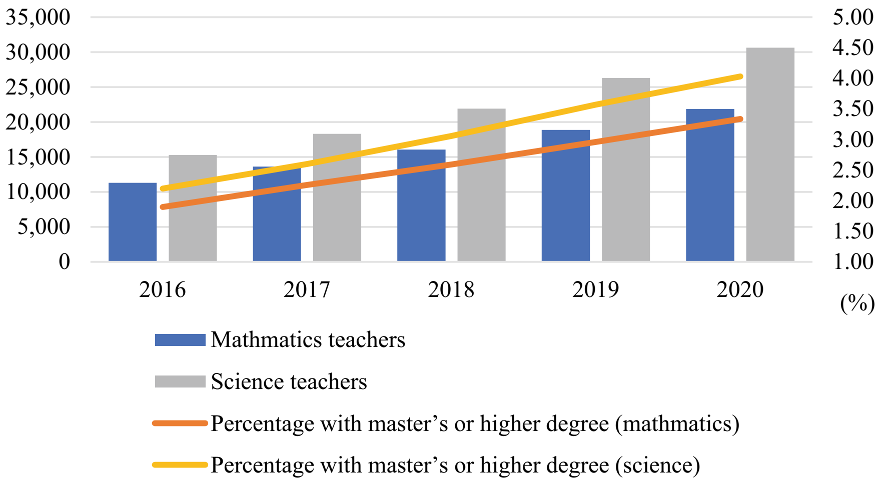

Fig. 5 Junior high math and science teachers with a master's or higher degree in China. *Source* Ministry of Education (MOE) (2016a, 2017a, 2018a, 2019a, 2020a)

between Chinese math and science teachers and their counterparts in this regard. The same is true when China compares to Japan and ROK.

One of the reasons that China falls behind is due to the Chinese education system. *Teacher Law of the People's Republic of China* promulgated in 1993 stipulated that, to be qualified to teach at a junior high school or vocational high school, one should graduate from a normal college, a tertiary vocational education institution, or other higher institution. (National People's Congress, 1993). It was not until November

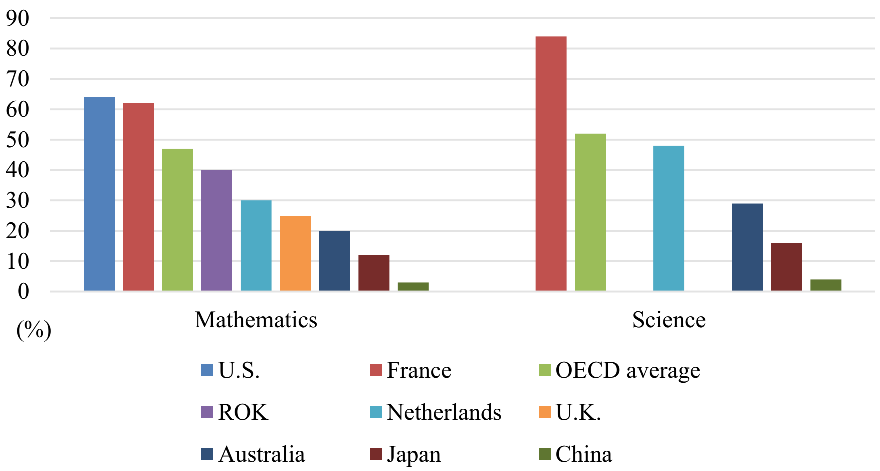

Fig. 6 Lower secondary math and science teachers with a master's or higher degree (%). *Source* National Center for Science and Engineering Statistics (2018); MOE (2020a)

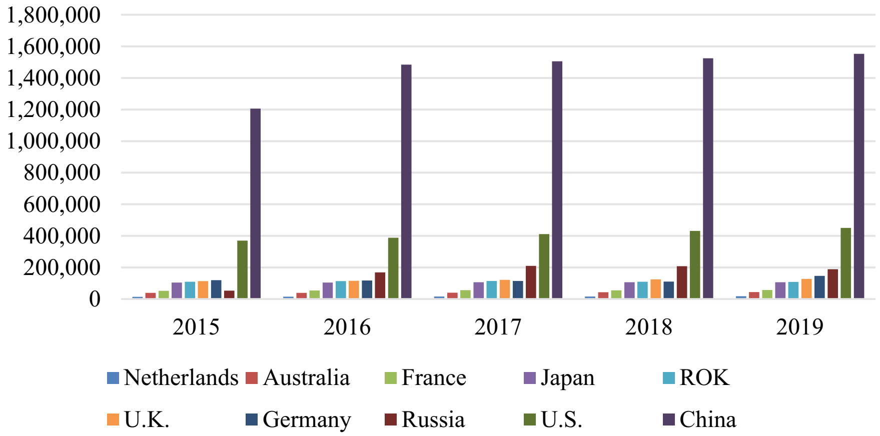

Fig. 7 Number of bachelor's degrees in STEM fields. *Source* OECD (2015, 2016b, 2017, 2018b, 2019b)

2021 that MOE amend the *Teacher Law* to require a bachelor's degree in teaching or related subjects from a normal college or university as the minimum qualification to teach at elementary and secondary education levels (MOE, 2021a). This suggests that it might take a long time to increase the number of teachers at Chinese schools to hold master's or higher degrees. It can also be argued that the credential gap between Chinese math and science teachers and their counterparts in developed countries will not disappear in a short term (Yao et al., 2021).

2.4 Bachelor's Degrees Awarded in STEM Fields

The scale of bachelor's degrees is a comprehensive and important indicator used to measure the outcomes of STEM education at tertiary education level. China boasts the largest number of STEM graduates in the world, and the number of STEM graduates is increasing every year as China's higher education becomes more accessible. In 2019, the gross enrollment ratio in tertiary education reached 51.06%, realizing a great leap from a mass to high participation (universal) higher education system. In the same year, the number of Chinese students with bachelor's degrees in STEM fields hit a record high of 1.55 million, increasing 28.74% compared with 2015. The U.S. has the second highest number of STEM graduates globally and has seen a growth year over year. The number of STEM graduates reached 449,900 in 2019, a 21.73% increase from 2015.

Figure 8 demonstrates that, while the percentage of traditional engineering graduates has declined in recent years, engineering still has the largest number of graduates

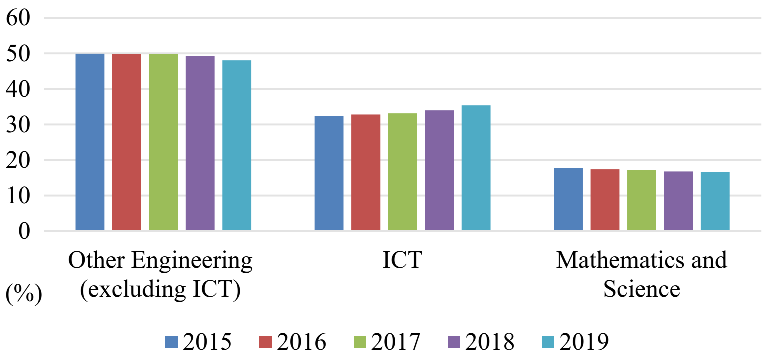

Fig. 8 Percentage of graduates in STEM fields. *Source* MOE (2015, 2016a, 2017a, 2018a, 2019a)

in China. The proportion of graduates in information and communication technologies (ICT) has been on a rise, accounting for one third of undergraduate students. The number of math and science college graduates remains fairly steady around 17%.

3 Excellence Indicators

3.1 Design

STEM excellence indicators are designed to highlight the outcomes of STEM education, aiming to analyze STEM education development and its features in different regions across the world, which also provide scholars and policy makers useful information to further promote STEM education and its quality.

While definitions and expectations of STEM education vary between countries, the goal of developing highly skilled workforce in STEM fields is shared among different education systems. Taking the fact that education is a continuous process in life, the indicators include characteristics of STEM education from middle schools to postgraduates (see Table 1) with the goal of representing both academic achievements and the scale and proportion of STEM talents. Research suggests that both academic performance and their career awareness influence students' decisions to pursue STEM careers. For example, the EngineeringUK report *Educational Pathways into Engineering* (2020) found that both underperformance in STEM and limited knowledge of the engineering profession impacted interest in engineering and students' future career choices and (Armitage et al., 2020). Moreover, with scientific, technological, and industrial revolutions in recent years, innovation capacity has become more and more valued. The next indicator focuses on the numbers of academic papers published in STEM fields, indicating innovation and research output. The final metrics focus on the percentage of STEM graduates and P&D personnel.

Table 1 Excellence indicators on STEM education

Educational level	Achievements	Scale	Proportion
Middle School	Number of medals in STEM Olympiads		High school students with STEM career expectations
Undergraduate	Number of STEM journal papers		Proportions of bachelor's degree awarded in STEM fields
Master		Number of master's degree awarded in STEM fields	Proportions of master's degree awarded in STEM fields
PhD		Number of PhD graduate in STEM field	Percentage of doctoral degree awarded in STEM field
Workforce			Percentage of R&D personnel

3.2 *Definitions and Sources*

In this chapter, education degrees, including the bachelor's, master's and doctoral degrees, are defined by the International Standard Classification of Education (ISCED) (OECD, Eurostat & UNESCO Institute for Statistics [UIS], 2015). STEM education includes four categories defined by OECD, namely natural sciences, math and statistics, information and communication technology, and engineering, manufacturing and construction (OECD, 2021).

3.2.1 The Numbers of Medals in STEM Olympiad

At the secondary education level, the number of Olympic awards in STEM disciplines is counted to represent student academic achievement. The total medals awarded in 5 STEM disciplines (Physics, Chemistry, Math, Biology, and ICTs) in 2021 are compiled from the Olympiad official websites.

3.2.2 Students' STEM Career Expectations

PISA tests include the students' survey on participated 15-year-old students' future career choices. This study includes two STEM-related occupations, "science and engineering" and "information technology" (IT), in PISA survey. Studies show that students' career expectations in middle schools will greatly affect career choices in the future (DeWitt et al., 2011; Hurst & Good, 2009). The latest data are retrieved from the PISA 2018 test.

3.2.3 The Number of Graduates in STEM Fields

To enhance scientific and technological innovation capacity, countries set higher requirements for STEM workforce. In response, the selected indicators focus on the numbers of master's and doctor's degrees awarded in STEM fields. The latest data are compiled from OECD and *Educational Statistics Yearbook of China 2019*.

3.2.4 The Proportions of STEM Degrees Awarded

Percentages of graduates in STEM fields at all educational levels also reflect the educational outcomes in the STEM fields. The percentages of STEM graduates with bachelor's, master's and doctoral degrees are all calculated based on the latest data retrieved from OECD and *Educational Statistics Yearbook of China 2019*.

3.2.5 The Percentage of R&D Personnel

The ultimate goal of STEM education is to provide high quality STEM workforce. It is important to know the proportion of actual STEM workforce. However, there is no consistent definitions of STEM-related jobs internationally, neither available nor comparable data for all the 10 countries. Therefore, in this chapter, the number of R&D personnel is employed to indicate the scale of STEM workforce. This data are retrieved from the "full-time equivalent (FTE) of personnel" in the latest fact-sheet 2019 published by UIS. The statistics refers to the full-time staff involved in the research and development work, who are engaged in improving or developing concepts, theories, models, techniques, tools, software and operating methods. The data as one of the key indicators representing national innovation investment have been widely used in mainstream innovation indicators reports, such as *Global Innovation Index 2021* published by World Intellectual Property Organization (WIPO) (2021) and *National Innovation Index Report 2020* released by Chinese Academy of Science and Technology for Development (2020).

3.2.6 The Numbers of STEM Journal Papers

In response to the growing attention on innovations, the total papers published in STEM fields are included as well. Data are retrieved from Clarivate[3] in 2021, which divides disciplines into 22 categories. This study includes 20 STEM categories, excluding two non-STEM disciplines ("economics & business" and "social sciences").

[3] https://incites.clarivate.com/zh/%23/analysis https://incites.clarivate.com/zh/#/analysis.

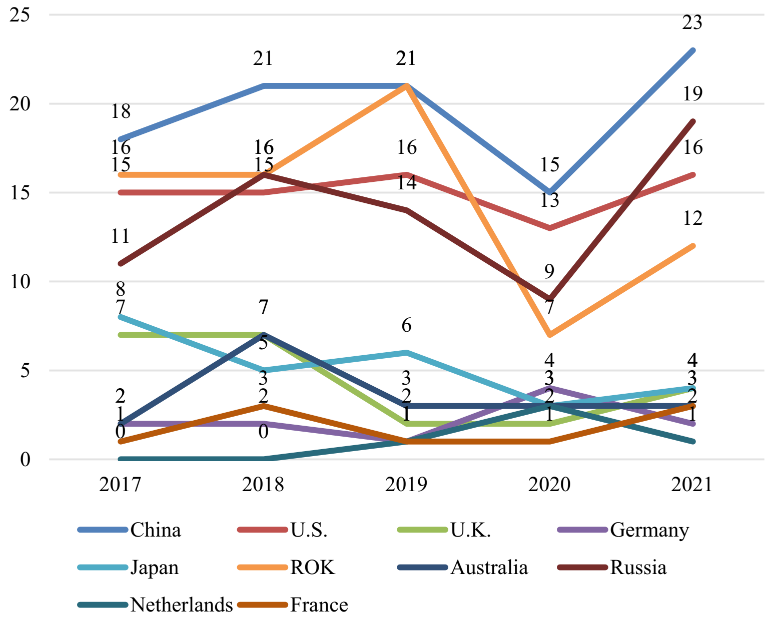

Fig. 9 The total number of gold medals in five STEM disciplines' Olympiad awarded to middle school students in ten countries. *Source* Compiled from IMO (2017–2021); IPhO (2016–2021); IChO (2017–2021); IBO (2017–2021); IOI (2017–2021). *Notes* The 2021 Physics Olympiad was canceled due to the COVID-19 pandemic, resulting in the absence of statistics on its official website

3.3 Findings

3.3.1 STEM Olympiad Awards

Middle school students' performance in five Olympiad disciplines serves as one of the representations of STEM excellence. According to the data released on the official website of the Olympiad,[4] for the past five years, Japan has led the 10 countries in medal count, and in the past two years, China, Russia and the U.S. have caught up and tied for the first place while the U.K. saw a slight decline.

In terms of gold medal count, China has led the 10 countries for the past five years, and ROK, Russia and the U.S. have also hold clear leads. Over the past five years, Russia and the U.S. have seen a significant increase in gold medals, placing second and third respectively in 2021. ROK, Japan and Britain, however, saw their counts fall slightly (see Fig. 9).

In terms of performance in each discipline, China, Japan, ROK, and Russia led the league in all the five disciplines. The U.K. was slightly behind in math and chemistry. Japan did particularly well in IT. The performance of the Netherlands can be hardly

[4] The 2021 Physics Olympiad was cancelled due to the COVID-19 pandemic, resulting in the absence of statistics on its official website.

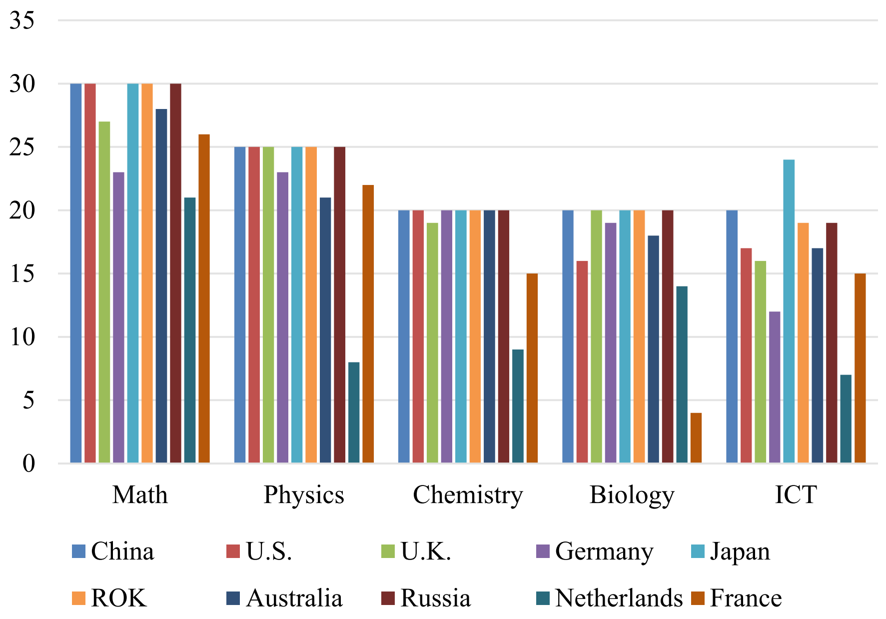

Fig. 10 Total medals in the five disciplines' Olympiad awarded to middle school students in the past five years (2017–2021) *Source* Compiled from IMO (2017–2021); IPhO (2016–2021); IChO (2017–2021); IBO (2017–2021); IOI (2017–2021). *Notes* Considering the statistical consistency of the five disciplines, participators from Taiwan and Hong Kong were not included in the number of Chinese winners. Medal count covers gold, silver and bronze medals with honorary awards not included

termed ideal in comparison with its counterparts, with four subjects at the bottom except biology with a relatively high score. France ranked bottom in terms of biology, but it performed well in math (see Fig. 10).

3.3.2 Students' STEM Career Expectations

Comparing the results of the recent two PISA tests (2018 and 2015) (see Fig. 11) shows an increase in the percentage of middle school students wanting to pursue STEM-related careers by age 30. The U.K. overtook the U.S. in this measure in 2018. Russia and Australia also showed fast increases, both overtaking the U.S. in 2018. The U.S. remained roughly stable in both surveys (15.1% in 2015 and 15% in 2018). The percentages of students in China wanting to pursue STEM-related career (8.8% in 2015 and 14% in 2018) remained lower than the average of OECD countries (11.4% and 15%), but with the gap narrowed, China's percentage surpassed Germany, Japan and ROK in 2018.

In terms of middle school students choosing information technology related careers, Russia was ahead of other countries (4.1% in 2015 and7% in 2018) for

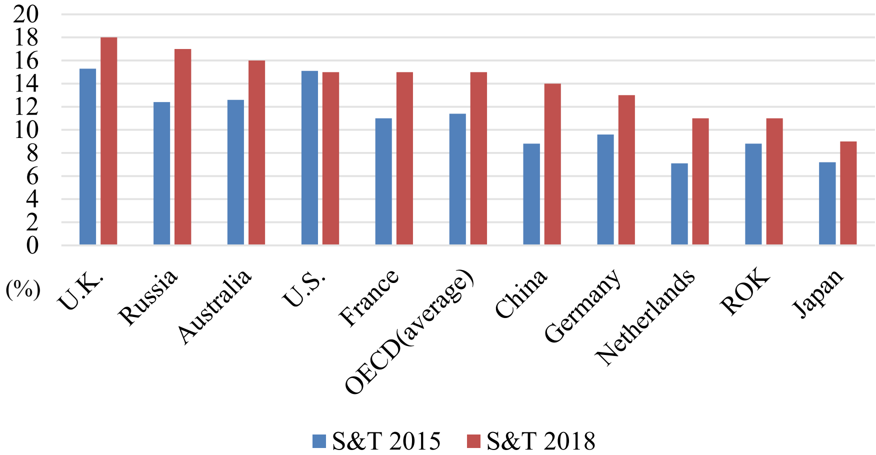

Fig. 11 Students' STEM career expectations: percentage of middle school students wanting to pursue STEM-related careers by age 30 (%). *Source* Compiled from OECD (2016a, 2019a).

both years. China saw an increase in the percentage of students wanting to choose information technology careers (from 2.1% to 4%), surpassing the OECD average level (2.6% in 2015 and 3% in 2018) in 2018.

3.3.3 The Proportions of Bachelor's Degrees Awarded in STEM Fields

STEM undergraduates account for the largest segment among all the undergraduates in China, with the proportion going to reach 40% in recent years (see Fig. 12). Since 2016, China surpassed Germany become the top among the 10 countries ever since, and followed by Germany (35%), ROK (near 30%), the U.K., Russia and the U.S. In the past five years, the Netherlands, Australia, the U.S. and Russia have all seen modest growth.

In terms of disciplines, the percentage of bachelor's degrees awarded in engineering, natural science, and information technology disciplines vary among countries. In 2019, for example, STEM learning was concentrated on engineering, manufacturing, and construction, as graduates majoring in these fields accounted for 65%–80% of the STEM graduates in countries including Japan, Germany, Russia, and ROK. In the U.K., the U.S., France, and Australia, 40%–55% of STEM graduates chose natural sciences, math and statistics. China witnessed a high proportion of graduates in ICTs at 35%, while a low percentage in science at around 15%, second only to Germany and Russia (see Fig. 13).

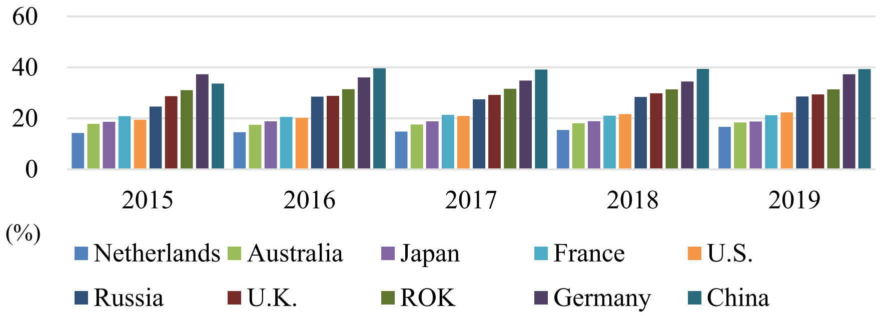

Fig. 12 Proportions of bachelor's degrees awarded in STEM fields (%). *Source* OECD (2015, 2016b, 2017, 2018b, 2019b); MOE (2015, 2016a, 2017a, 2018a, 2019a)

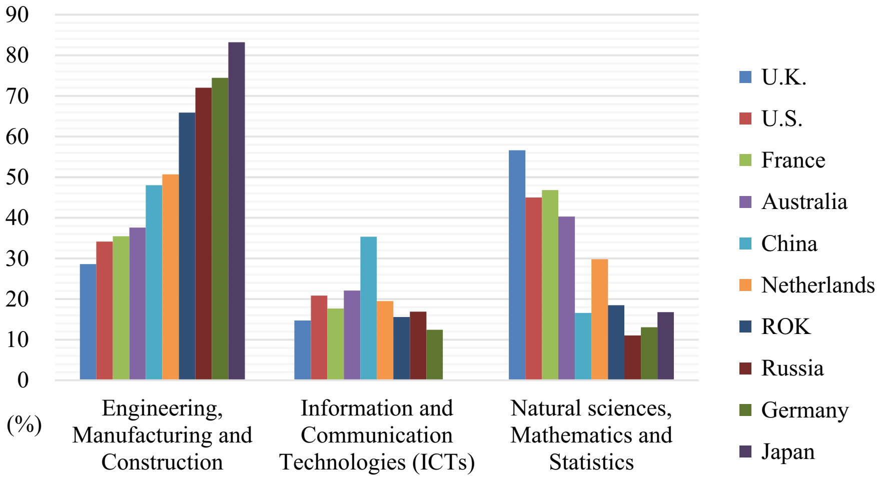

Fig. 13 Percentage of engineering, information and science graduates in 2019 (%). *Source* OECD (2019b); MOE (2019a). *Notes* Chinese STEM graduates consist of science and engineering. Engineering is composed of ICTs and other engineering majors. ICTs majors include electrical appliances, electronic information, automation and computer, and other engineering majors refer to 27 categories such as Mechanics. Japan's ICTs graduates are scattered across other fields

3.3.4 The Number of Master's Degrees Awarded in STEM Fields

After overtaking Russia in 2017, China has consistently topped the world in terms of the number of STEM postgraduates. As shown in Fig. 14, the U.S. ranked second worldwide, with roughly 153,000 for three consecutive years. Russia was far ahead of other countries in 2015 and 2016, but it has witnessed a significant decline in recent years. There were 238,000 STEM postgraduates in China in 2019, 1.6 times that of the U.S. Moreover, this figure has steadily increased year by year, with 24,000 more in 2019 than in 2015, realizing an increase of 11.17%.

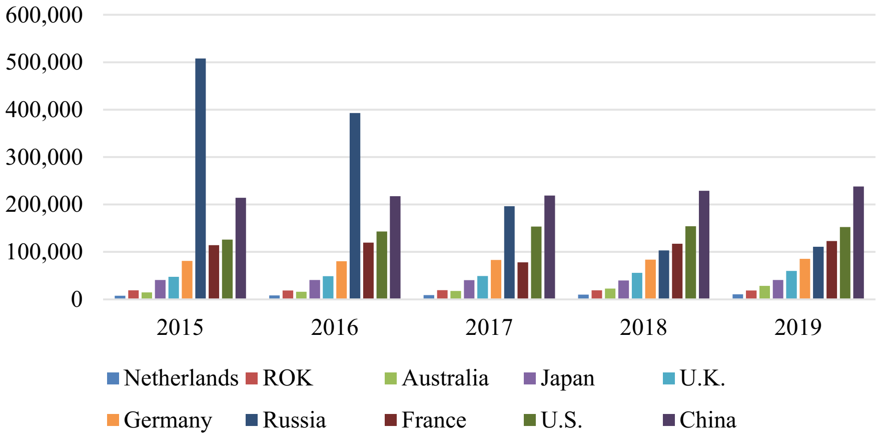

Fig. 14 The number of master's degrees awarded in STEM fields. *Source* OECD (2015, 2016b, 2017, 2018b, 2019b); MOE (2015, 2016a, 2017a, 2018a, 2019a).

3.3.5 The Proportions of Master's Degrees Awarded in STEM Fields

China has maintained the highest percentage of STEM master's degree recipients, with the figure maintaining more than 40% in recent years (see Fig. 15). Japan was the next with a ratio of one-third. The third place went to Germany, steadily keeping at 30%. Russia ranked fourth, with a significant increase in 2018.

In terms of the percentage of master's degrees in engineering (including engineering, manufacturing, construction, and ICTs) and science (including natural

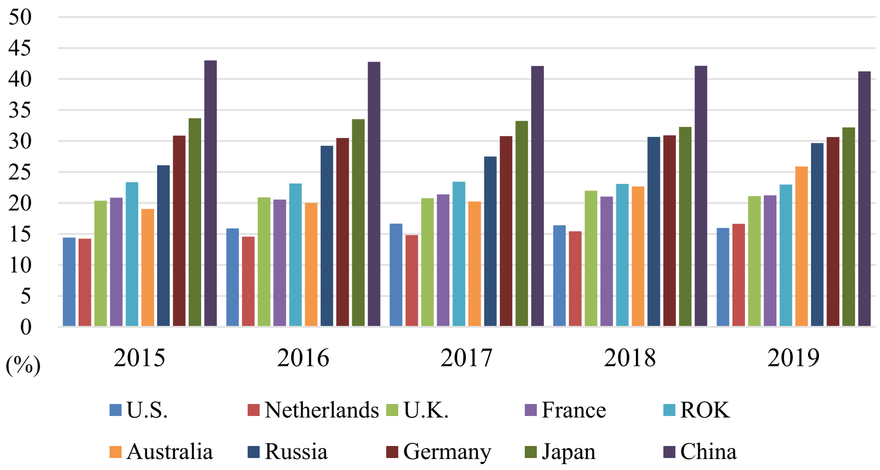

Fig. 15 Percentage of STEM master's degree recipients in ten countries (2015–2019) (%). 2015, 2016a, 2017a, 2018a, 2019a *Source* OECD (2015, 2016b, 2017, 2018b, 2019b); MOE ()

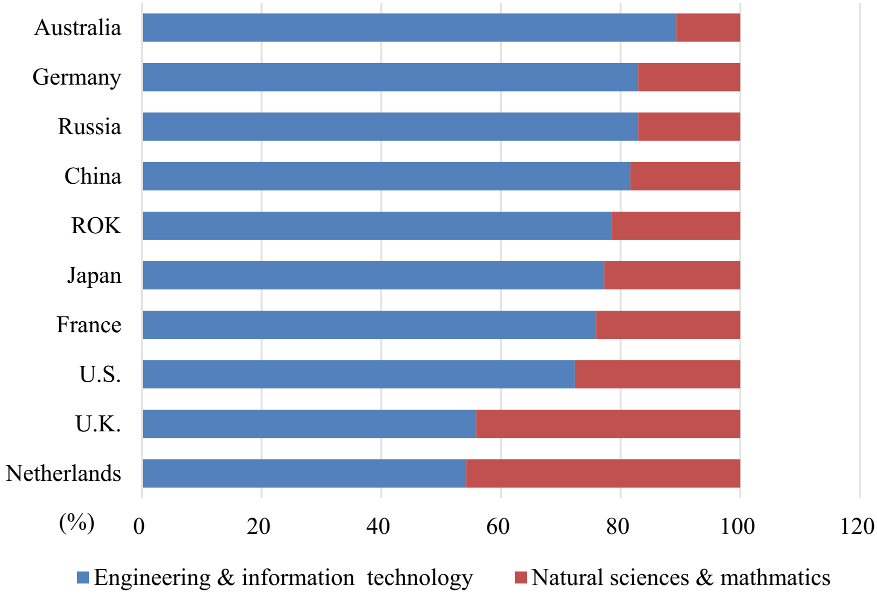

Fig. 16 Percentage of master's degree graduates in engineering related and science related disciplines in 2019 (%). 2019a *Source* OECD (2019b); MOE (2019a)

science, math and statistics), those majored in engineering in China, Australia, Germany and Russia all accounted for more than 80% (see Fig. 16), while in the Netherlands and the U.K., the largest proportion went to those majored in science, both beyond 50%.

3.3.6 The Number of PhD's Degrees Awarded in STEM

China and the U.S. are home to the largest number of doctoral students in STEM, with the number of doctoral graduates steadily increasing year by year, the gap between the two countries is nevertheless widening at the same time. In 2015, China had 29,707 STEM doctoral graduates, 775 more than that in the U.S.; and by 2019, the number had reached 36,946 doctoral graduates, and widening the gap to 6,241 (see Fig. 17).

3.3.7 The Proportions of Doctoral Degrees Awarded in STEM Fields

China had the largest proportion of doctoral degrees in STEM fields, approaching 60% in recent years (see Fig. 18). The second was France. Although it remained above 60% until 2017, the ratio declined sharply in the past two years. The U.K. ranked

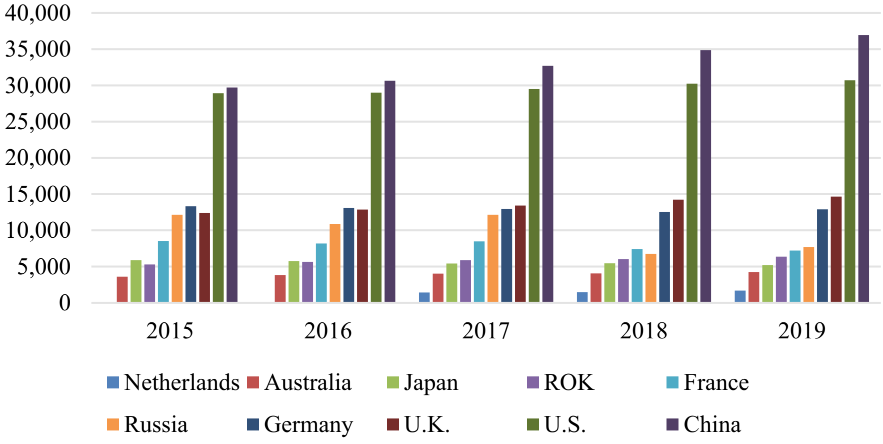

Fig. 17 The number of PhD's degrees awarded in STEM fields. *Source* OECD (2015, 2016b, 2017, 2018b, 2019b); MOE (2015, 2016a, 2017a, 2018a, 2019a)

third, with steady year-on-year growth, most recently reaching 50%. Germany and Australia took fourth and fifth place respectively.

At the doctoral level, doctoral graduates in engineering-related fields in China, ROK and Japan took the largest share at home, each exceeding 60% (see Fig. 19), with the proportion in ROK reached nearly 70%. In France, Germany and the U.K., those in science-related fields account for the highest ratio, with each above 60%.

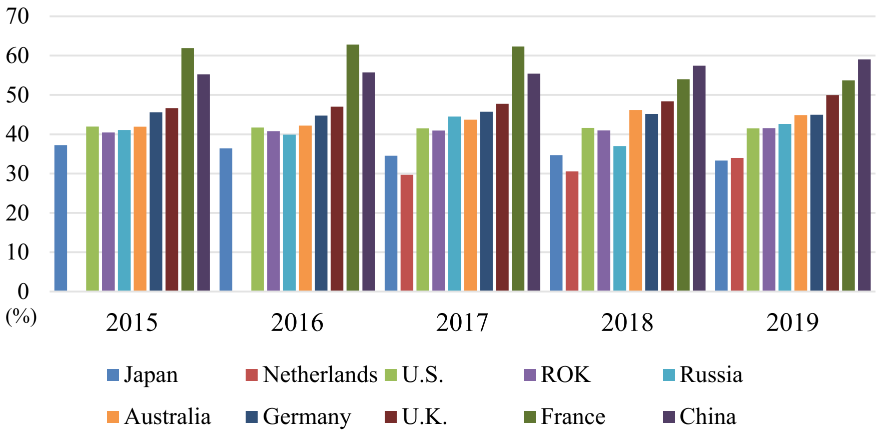

Fig. 18 The proportions of PhD's degrees awarded in STEM fields (%). *Source* OECD (2015, 2016b, 2017, 2018b, 2019b); MOE (2015, 2016a, 2017a, 2018a, 2019a). *Note* Data for the Netherlands in 2015 and 2016 are not available

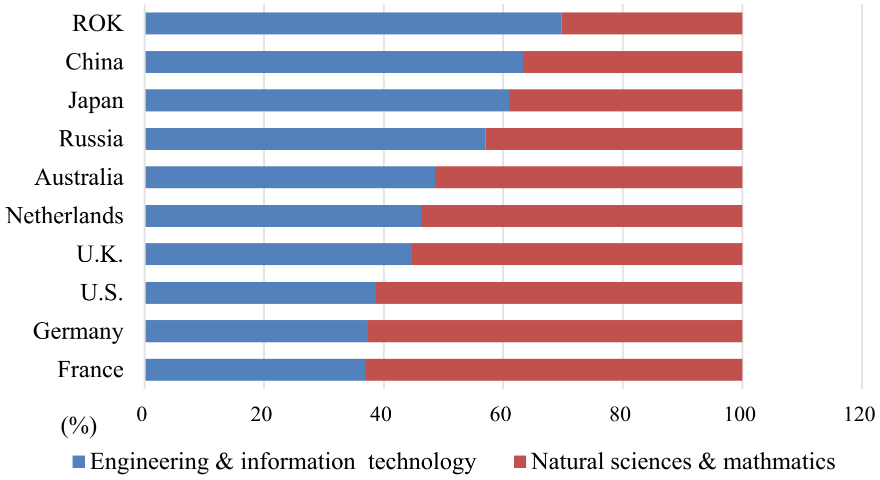

Fig. 19 The percentage of engineering and science PhD degrees in 2019. *Source* OECD (2019b); MOE (2019a)

3.3.8 The Numbers of R&D Personnel

The proportion of full-time equivalent (FTE) of research and development (R&D) personnel in every million populations in 2019 is presented (see Fig. 20). ROK had a far higher proportion than any other country, followed by the Netherlands, Germany, and Japan. In comparison, Russia and China were far behind other countries.

3.3.9 The Number of STEM Journal Papers

As one of the critical outputs of STEM education, the number of STEM papers reflects the progress of national STEM innovation. China has witnessed a rapid increase in the number of STEM papers year by year, rising from 357,800 in 2017 to 615,900 in 2021, with an increase of 72.13%. Internationally speaking, China surpassed the U.S. for the first time in 2021 to become the world's largest STEM paper producer (see Fig. 21). In the same year, the number of STEM papers published in China was 3.44 times that of the U.K. and 5.55 times that of Japan.

3.4 Discussions

Based on the statistics shown above, the scores of excellent STEM education are standardized by valuing the country with highest achievement of each indicator as 100, and value the rest countries accordingly. The data used in this section is the latest available. Among them, both the proportion and scale indicators used data

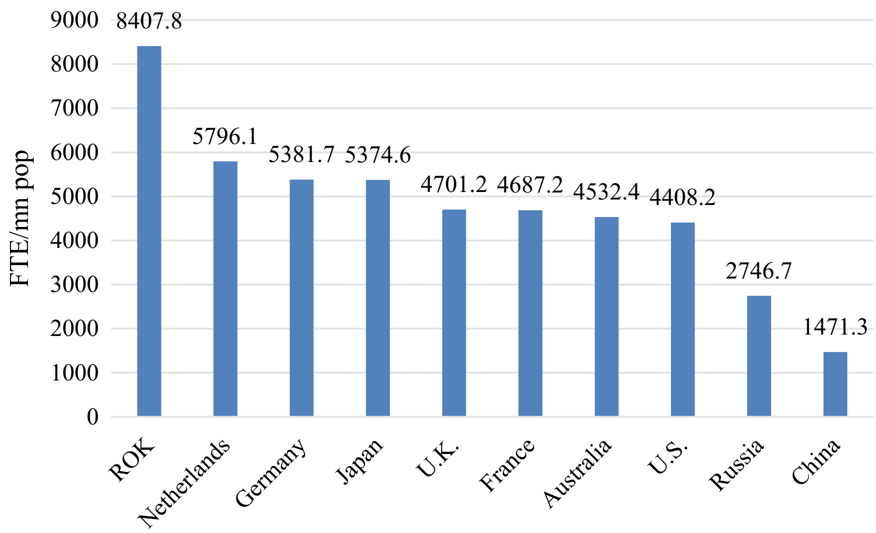

Fig. 20 Full-time staff involved in the research and development work in 2019. *Source* WIPO (2021)

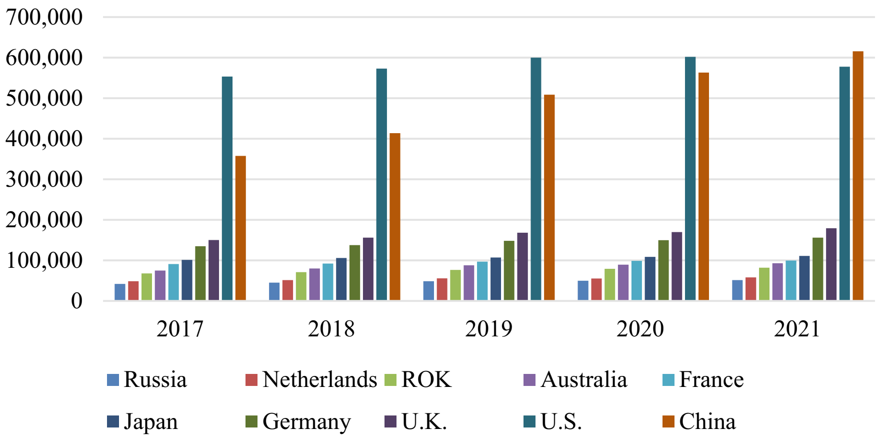

Fig. 21 The number of papers published in STEM fields (2017–2021). *Source* Clarivate (2017, 2018, 2019, 2020, 2021)

of 2019, the career expectations of 2018, the Olympiad results and journal papers of 2021.The 10 countries are ranked in terms of STEM education excellence as following: China, the U.S., Germany, the U.K., Russia, ROK, France, Australia, Japan, and the Netherlands (see Table 2). China ranks first not only in the number of graduates receiving STEM master's and doctoral degrees and the proportion of STEM undergraduates, postgraduates, and doctoral graduates, but also on the performance of middle school students winning Olympiad medals. In terms of the number of researchers and Olympiad medals ROK topped the list. The U.S., Russia, and Japan all performed well in the Olympiad, while the U.K. acted outstanding in STEM career expectations of middle school students. Though Germany did not lead the 10 countries in any single indicators, its comprehensive performance earned it the third place in general. The European countries and Australia all suffered low numbers of STEM graduates at both undergraduate and post-graduate levels. This finding is consistent with CEDEFOP's skill report in 2016 (CEDEFOP, 2016) which found that entry requirements and dropout rates are high at STEM disciplines at upper-secondary and higher education. "Some countries also suffer from 'brain drain' as STEM professionals emigrate for better jobs elsewhere." (*ibid*) However, the rates of STEM undergraduates in Germany are high, which is the second place among 10 countries. Most European countries and Australia show the relative advantages on the number of doctoral graduates.

Differently, Asian countries (China, Japan and ROK) are particularly outstanding in ICTs, leading in the number of middle school students winning Olympiad rewards, the proportion of graduates with master's and doctoral degree and academic papers published, which could be attributed to the differentiated competition strategies of Asian countries in STEM.

When demographic factors are excluded, the competitive advantage of all countries, from doctoral graduates to R&D personnel is declining, with the exception of ROK, Japan, and the Netherlands. It is also interesting to notice the different development patterns among the countries. China shows a different pattern from the others, which are high in producing master's and doctoral graduates in STEM, but low in middle school students' STEM career expectations and actual proportion of R&D personnel. This phenomenon could be related to "credential inflation" in China, which has led to many graduate students' not pursuing careers in their majors. Although ROK and the Netherlands are comparatively low in the number of STEM graduate students, they still show an upward trend of producing STEM practitioners, from master's to doctoral level and turning out to commitment in R&D. Japan is very competitive with master's students in STEM fields. Germany shows a steady pattern all the way from middle school to R&D. The U.S. and Russia still show the features of "leaking waterpipes", both of which are high at middle school students' STEM career expectations, and decreasing their competitive advantages through master's and doctoral graduates, and low in R&D.

As for academic achievement, China and the U.S. outperformed at both the secondary level and the number of academic papers produced in STEM fields. Comparatively, ROK and the Netherlands both published fewer STEM papers. However, it is important for STEM education to contribute workforce in STEM fields, both sufficient in quantity and high in quality. The U.S., Germany, and the U.K. show relative advantages in terms of proportion of R&D and research papers in STEM fields.

Table 2 Rank of STEM Excellence Indicators (standard score)

Countries	Awards in STEM Olympiad	STEM Career expectations	The proportion of undergraduates	The number of postgraduate	The proportion of postgraduates	The number of Doctoral graduates	The proportion of Doctoral graduates	The number of researchers	Number of STEM papers	Total
China	**100**	77.8	**100**	**100**	**100**	**100**	**100**	17.5	**100**	100
U.S	**100**	83.3	56.8	64.1	38.8	83.1	70.4	52.4	93.8	80.8
Germany	87	72.2	94.8	35.8	74.3	34.9	76.2	64	25.3	71
U.K	87	**100**	74.8	25.2	51.2	39.7	84.6	55.9	29.1	68.8
Russia	**100**	94.4	72.8	46.6	72	20.8	72.2	32.7	8.3	65.4
ROK	**100**	61.1	79.7	7.9	55.7	17.2	70.4	**100**	13.3	63.5
France	56.5	83.3	54	51.7	51.5	19.5	91	55.7	16.4	60.3
Australia	82.6	88.9	46.8	11.9	62.8	11.5	76	53.9	15.1	56.5
Japan	**100**	50	47.8	17.1	78.1	14.1	56.4	63.9	18	56
Netherlands	52.2	61.1	42.3	4.5	40.4	4.6	57.5	68.9	9.4	42.9

4 Best Practices

There are some common global challenges, such as attracting young students, involving scientists and practitioners in STEM education, and seizing opportunities offered by the news media. In response, this section presents best practices and experiences in promoting STEM education in China.

4.1 Strengthening the Development of Innovative and Outstanding Workforce in Basic Disciplines

In order to meet Chinese major strategic demands, it is critical to have well-educated and innovative young talents in basic disciplines, such as math, physics, chemistry, biology, etc. Therefore, Chinese government has carried out reforms in student admissions as well as curriculum to develop innovative workforce in basic disciplines across higher education.

Since 2009, MOE has organized top universities to establish training centers for developing young talents in basic disciplines, known as the Young Talent Program 1.0. For example, Shanghai Jiao Tong University (SJTU) set up Zhiyuan College[5] in 2010, with the latter committed to cultivating innovative talents that will play a leading role in China's socio-economic development and in global scientific and technological advancement. With the support of MOE, SJTU initiated the "Top Students in Basic Discipline Cultivation Plan", a pilot program in accordance with the national education reform. Faculty at the college are world-leading experts and outstanding professors, including Nobel laureates and Turing Award winners. "Zhiyuan Honors Curriculum" has been set up to guarantee its teaching quality, featuring a "curiosity-driven" model. Both seminar and discussions groups are employed to create interdisciplinary learning environment. Meanwhile, different approaches have been adopted to sustain students with a thirst for knowledge, especially for those top 10%. These approaches include strict qualification examinations as well as flexible and competitive approaches to allow excellent students to join the class. As a result, 618 graduates in the first seven years went on further studies in top universities at home and abroad.

Many top universities, like SJTU, have been selected and engaged in the Young Talent Program 1.0 and trying different ways to improve their educational quality. From 2012 to 2018, 5,500 graduates graduated, and 9,800 undergraduates were supported by the program. The graduates have demonstrated a strong interest in basic discipline research, and 97% of them have pursued further studies in basic disciplines and related fields. Students in this program show potential to become future scientific leading figures. The participating students published a total of 2,029 papers in SCI journals and won 5,788 awards.

[5] https://en.zhiyuan.sjtu.edu.cn/.

In 2020, MOE further initiated the enrollment reform and carried out a pilot scheme in some universities, known as *Strengthening Basic Disciplines Plan* (China Education Daily, 2020). The vision of the plan is to shift the practice of evaluating students simply by examination results to a comprehensive evaluation of students. It aims to select and cultivate students who are interested in serving the major strategic needs of the country and have excellent comprehensive quality or are outstanding in basic disciplines. In the admissions system, the *Strengthening Basic Disciplines Plan* selects two main groups: students with excellent performance in the college entrance exams (the Gaokao) and a small number of "genius students" who are prominently talented in certain disciplines. Admissions reforms allow many students to access education in basic disciplines, breaking through the limitations of the college entrance exams.

China's science and technology innovation enterprises also play an active role in developing an innovative workforce. Ministry of Science and Technology and Ministry of Finance of China (2022) jointly issued the policy to encourage science and technology innovation enterprises to build a favorable environment for innovative talents in basic disciplines in 2022. For example, Huawei, a Chinese tech giant, cooperates with top universities (e.g., Huazhong University of Science and Technology) and local universities (e.g., three engineering universities in Hubei Province) to further promote the cultivation of new engineering talents.[6] Also, Huawei built vocational colleges like Huawei ICT Academy with Shanghai Sanda University in 2018. Moreover, many innovative companies also offer new technology equipment and build "smart classrooms" with new technology to support the students' STEM competence development in the higher education institutions. Furthermore, innovative companies also organize in-service training to their employees, improving the quality of the STEM workforce. For example, Huawei launched the Genius Recruitment Program to recruit brilliant youth from around the world in 2019. In 2020 and 2021, Huawei employed 26,000 fresh graduates, including more than 300 "talented youths" as defined by Huawei, who boast special achievements in math, computers, physics, materials, chips, intelligent manufacturing, chemistry, and other related fields and who aspire to become leading figures. Huawei said it would provide talented youngsters with excellent mentors, global vision, platforms, and resources, and more than five times remuneration.[7] With Huawei as the representative, Chinese innovative companies recruit young talents in the field of science and technology globally with high salaries, encouraging outstanding graduates to work in science and technology industry, and attracting more young students to choose science and technology majors.

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[6] https://www.huawei.com/cn/news/2021/12/kunpeng-ascend-education-base.

[7] https://www.thepaper.cn/newsDetail_forward_17811045.

4.2 Scientists' Engagement in Science Education in Elementary and Middle Schools

As an important strategy to enhance young students' science literacy, China has systematically organized and facilitated scientists to lead youth science education activities. The scientists are supported to deliver courses that can be integrated with school science education and suitable for young students. The courses focus on inspiring students' scientific interests, fostering their innovative spirits and competencies, enhancing their understandings of scientists and scientific spirit. For example, Zhejiang Provincial Department of Education has organized the 100 Scientists in Elementary and Middle School Classrooms program in the province since 2022 (Zhejiang Provincial Department of Education, 2022). By inviting famous scientists (including experts and scholars in other fields), courses are offered across the province, allowing students to interact face-to-face with scientists. The content of the courses is designed around the themes of life navigation, highlighting the value guided scientific practices, inspiring young students' scientific interests, and explicitly introducing scientific minds. It is also designed to enhance students' innovation abilities and raising their cultural awareness.

This program has been officially launched in February 2022. Shi Yigong, President of Westlake University, delivered the "First Science Lesson" themed "On Young China" to elementary and middle school students in the province, guiding them to understand what science is and how to learn science well, and encouraging them to explore the science and actively engaging and participating in national development and scientific innovations. Currently, the 100 Scientists in Elementary and Middle School Classrooms program has become an important activity in Zhejiang Province, integrated into the curriculum and teaching plan of elementary and middle schools across the province. The 90-min lecture is delivered once a month (Zhejiang Provincial Department of Education, 2022). The interaction between scientists and teenagers has become a part of the formal school curriculum. Through live broadcast and interactive Q&A with teachers and student, all elementary and middle school students can learn "in the same class", including the students in rural and underdeveloped areas.

4.3 New Media to Promote Science Popularization to Young People

In recent years, with China's mobile internet development, new media including social media platforms and short videos has become popular especially with young people. New media has become an important way for science engagement and publication, including STEM online courses. The use of new media has not only opened channels for popular science knowledge to reach the public but also become an important tool to ignite the interest of youth in STEM.

The new-media-based science popularization can be roughly categorized into three forms. The first form is general scientific contents, delivered in the form of short videos and usually contributed by laypeople or whoever is interested. The content covers a wide range of entertainment-oriented, easy-to-understand knowledge, without guaranteed scientific validity. The second form is science classes offered by people with relevant higher degrees or science tutors, targeting audiences who are interested in further studies, including the students preparing for college entrance exams or graduate school entrance exams. The third form is lectures offered by leading academics. Prominent academics in various fields are invited to deliver lectures for public with authority and validity in contents. For example, Zheng Zhao, Professor of physics at Beijing Normal University, has created an account called "Zheng Zhao Introduces Physics" on the Bilibili video website (a popular Chinese video sharing website), which attracted more than 75% of the audience aged from 18–35. Professor Zhao talked the origin of the universe and the life of Stephen Hawking, popularizing physics knowledge for ordinary netizens. The most popular videos of Zhao include the formation of black holes and how to prove the general relativity theory.

In addition to the individual contributors, science and research institutes are also actively exploring new channels and ways of science communications. Institute of Physics at Chinese Academy of Sciences (IPCAS), a top research institution for basic and applied research in physics in China, has launched a series of popular science videos on its official website. For example, the column of "Understanding Physics in the Clouds (*Yun Li Wu Li)*" has been created for young students, in which scientists teach the history and basic knowledge of science in the fields of sound, light, electricity, and magnetism (IPCAS, 2022a). Meanwhile, a series of popular science cartoons for children, "Dr. Marmot", focus on the scientific phenomenon in daily life and present in an interesting and relaxing manner. In November 2014, the institute's WeChat official account was created, which was the first Chinese research institution utilizing social media account to publish popular science content (Wu, 2022). The official account gained 100,000 followers in the first year, of which more than 70% were students aged 14–26 (Wu, 2022). To further promote science communication with teenagers, IPCAS has set up a "Q&A" column on their official web account to answer the most popular questions from teenagers in the comments every week. Later, two other columns, "Seriously Play" and "Online Science Day", have been set up, with the former demonstrating, explaining small physics experiments and illustrating a certain physics knowledge or phenomenon, and the latter introducing the history and anecdotes of physics development (Wu, 2022). In March 2019, to adapt to the fragmented learning style of youth groups nowadays, IPCAS created an official account on Bilibili, gaining favor among teenagers by cleverly designed small scientific experiments and live science broadcasts full of creative ideas. Now, the account has released 870 short science videos and gained 1.833 million followers (IPCAS, 2022b). In January 2022, IPCAS launched a science popularization program for elementary and middle school students, "Science Open Class", featuring more than 20 scientists from the institute. Academic physics knowledge has been transmitted to the teenage students in a relaxing and vivid manner, providing the opportunity for students to get closer, understand and get in touch with physics. This has generated a wide impact. In March 2022, IPCAS was selected as one of "the First National Science Education Bases in 2021–2025." In June 2022, the institute held "Public Science Day 2022" online. The broadcast livestream ran nonstop from 12:00 a.m. to 22:00 p.m. (IPCAS, 2022c). Academicians, young scholars, and celebrities gathered together to present an amazing scientific event that teenagers could embrace. Follow the examples of IPCAS, higher education and research institutions have actively participated in the online science communication and public engagement.

5 Inspiring Stories

This section tells the stories of a Chinese female astronaut, a world-leading scientist, and a technology enterprise CEO, who have made in STEM fields and also actively contributed to the STEM education for public and talents.

5.1 Wang Yaping: Nurturing Students' Passion for Technology Innovation Through Space Classes

On December 9, 2021, Shenzhou-13 astronauts Wang Yaping, Zhai Zhigang and Ye Guangfu started the first lecture of China's space education brand activity "Tiangong Class", the second space class from Chinese astronauts and the first teaching activity on the Chinese space station. As China's first teacher teaching from space and the first female astronaut boarding on Tiangong-1, Wang Yaping stood on the "highest podium" during the flight of Shenzhou X and Shenzhou XIII manned missions in 2013 and 2021 respectively, giving two lectures to Chinese elementary and middle school students, planting the seeds of pursuing scientific dreams in their heart. It is a great chance to present peculiar physical phenomena and impart scientific knowledge during the flight. "As a female astronaut, it has always been my dream to deliver a class for children", Wang said (Wang, 2022). In order to achieve the best teaching effect, she had revised the lecture scripts several times, constantly rehearsed, repeatedly experimented to simulate the demonstration process, and read multiple books on curriculum pedagogy, educational psychology, and other fields in just one month (People's Network, 2013). The lecture content was about the feature of object movement in the microgravity environment. In 2013, Wang Yaping and Nie Haisheng displayed some basic physical rules including Newton's first law, Newton's second law, the phenomenon of weightlessness in space, the law of conversation of angular momentum, surface tension of the liquid, etc. Through the experiments, students intuitively understood physical phenomena that are rarely seen on Earth, which deepened their understanding of basic physics principles. In 2021, Wang Yaping, together with several astronauts, vividly showed the amazing phenomena in the fields of cytology, including motion, and surface tension of liquid in the microgravity environment and highlighted the scientific principles behind the experiments. Meanwhile, Wang and other astronauts interacted with teachers and students on Earth, answered questions around manned space technology, space flight, space science and astronauts' work and life in space.

The two livestreamed classes have had a great social impact in China, helping youth to explore space, enabling them to be more passionate about the space programs, and inspiring their aspirations for space and enthusiasm for learning science and technology. After the "Tiangong Class", the students from Beijing No. 4 Middle School wrote a letter together to Wang in space, and received a reply a few days later, in which Wang depicted the amazement of flying over the motherland and having a bird's-eye view of the picturesque landscape and said she felt a strong sense of responsibility of being a taikonaut. She expressed sincere encouragement to the scientific visions of young students, "I earnestly hope that more youngsters can join us and carry on the mission. As long as you have a dream, pursue it, and build your dream spaceship with wisdom and sweat, you will definitely be able to celebrate the launching moment of your dreams and fly to the vast starry sky" (Xinhua, 2022). Years after Wang returned, she keeps receiving letters from students who aspired to be astronauts, some of whom are already enrolled in aerospace programs, and some even become Wang's colleagues, contributing to Chinese space industry. Wang's space lectures and interactions not only spread the knowledge and culture of manned spaceflights, but also stimulated young people's curiosity about science and inspired more students to establish their future aspirations to join scientific undertakings.

5.2 Zhang Chaoyang: Letting the Charm of Physics Shine Through the Innovative Short-Video Platform

Zhang Chaoyang (Charles Zhang), CEO of Sohu, also known as the godfather of the Chinese Internet enterprise, has become popular again in recent years as a "physics teacher". At the age of 17, Zhang was admitted to the department of physics in Tsinghua University. After graduation, he went to the U.S. to pursue his doctoral degree in physics at MIT and he won the "Tsung-Dao Lee Scholarship" established by Dr. Tsung-Dao Lee, winner of the Nobel Prize in Physics, and continued his post-doctoral research there. At the end of 1995, Zhang returned to China and founded the first Chinese Internet enterprise with venture capital funds in 1996. The first product was launched in 1998 when the company changed its name to Sohu, becoming one of the four most popular websites in China in that time. It has now developed into an Internet enterprise specializing in new media, communication and mobile value-added services. On November 26, 2021, Sohu ranked 19th in "China's Top 100 Internet Enterprises with Comprehensive Strength", and this was the ninth consecutive year for it to enter the top 100 list (Internet Society of China, 2021). Zhang's experience as a successful Internet entrepreneur has encouraged many young people, and his career trajectory also represents the career diversity in STEM field.

In 2021, Zhang started his live-streaming physics course on Sohu; and the series of "Zhang Chaoyang's physics class" have aired more than 30 episodes so far.[8] As a well-known entrepreneur, Zhang's courses have attracted crowds of young people. In 2022, Zhang's classes moved from cyberspace to the off-line classroom, where he taught audience how to derive the theory of relativity and wave equation, making courses went viral once again. With the help of new media shaped by technological innovation, he spread scientific knowledge, stipulated the youngsters' interests in science, and promoted education with science and technology. In his offline class, Zhang once talked about his understanding about science and technology, "We should think of the basic concepts such as speed, energy, basic definitions and rules when facing problems, which is the essence of physics and math. Science must be built on the calculation and orders of magnitude. That's what makes it a good and hardcore science!" Zhang's love for science makes his life more endurable. As he stated, Zhang hopes that his physics classes can inspire audience to be curious and willing to understand the mystery of the world. "Since the birth of modern science, human beings have accumulated abundant knowledge in just a few centuries, which requires to be known."[9]With the support of new media, hardcore science bloggers represented by Zhang, are passing scientific knowledge, spirit and passion on to the new generation.

5.3 Shi Yigong: Exploring New Approaches to Cultivate Technological Talents

In the field of biological science today, Shi Yigong is undoubtedly a leading figure. As the laureate of the Future Science Prize in life sciences, Shi is a world-renown expert in the field of apoptosis, protein dephosphorylate, and SMAD protein signal transduction. As the founder of Westlake University, Shi has brought new thinking to the higher education reform and a new practice of cultivating scientific and technological innovation talent.

As a world-class scientist, Shi found his research interests during his undergraduate studies. He showed his passion for science at a young age and was recommended to join China High School Biology Olympiad during his years at Henan Experimental High School, one of the leading middle schools in Henan province. He won the first prize in the national competition and was then recommended to be admitted into the Department of Biological Sciences and Biotechnology of Tsinghua University. It was during his study time at Tsinghua University that he deeply felt the charm of biology. With immense zeal and excellent performance, he graduated with bachelor's degree in 3 years in 1989. In 1995, Shi received a doctorate in molecular biophysics from the School of Medicine at John Hopkins University and continued

8 https://www.bilibili.com/video/BV1L34y1t7Pz.

9 https://www.sohu.com/a/556002230_153916.

his postdoctoral research at Memorial Sloan Kettering Cancer Center in the U.S. Shi's success in scientific research frontier has encouraged many young students to devote themselves to scientific enterprises.

Recalling his study time, Shi thought highly of the experience of his undergraduate studies and was determined to cultivate young scientists. In 2008, resigned from Princeton University as a Full Professor, Shi returned to China, shifted his focus from experimental research to talent cultivation, and took the role of the Dean of Department of Biological Sciences and Biotechnology at Tsinghua University, where he guided a batch of high-quality and high-level young talents. On April 6, 2018, Shi founded Westlake University, the first government-supported and private-run new research university in China, to develop the innovative cultivation of top talents in basic science. Shi has continued his efforts to improve higher education by cultivating young talents with innovation abilities in STEM fields at multiple universities. Westlake University aims to cultivate top innovative talents and future leaders with a strong sense of social responsibility. Instead of employment-oriented development, the university advocates paying more attention to the cultivation of talents and commitment of socially responsible research. As Shi said, "We hope that in one or two decades, in Hangzhou, Zhejiang province, there will be a world-renowned higher education institution with Chinese characteristics, and that is Westlake University. It will be home to a batch of the most outstanding scientists in the world, cultivate the most excellent young talents and engage in cutting-edge basic and applied research. Westlake University also aims to explore scientific research and education systems and mechanisms in line with China's national conditions, supporting the sustainable development of China's high-tech industry as a powerful engine, and making China's contribution to world civilization!"[10] The university now has more than 600 doctoral students and gathers over 100 experts in different disciplines from all over the world.[11] By March 2022, the university has set up two campuses, three sub-colleges, and five undergraduate majors. It has achieved world-leading research findings in the field of structural biology. In 2022, the university will enroll undergraduate students for the first time. Many top scientists in China, like Shi, has committed to the process of improving higher education in STEM fields, based on their own experience of scientific practices.

6 Latest Research

This section reviews the recent STEM education research published in Chinese academic journals from 2012 to 2021. There are 534 articles selected from core journals in Chinese Social Sciences Citation Index (CSSCI), further analyzed by CiteSpace V software with keyword co-occurrence and cluster analysis.

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[10] https://www.thepaper.cn/newsDetail_forward_2159031.

[11] https://en.westlake.edu.cn/about/.

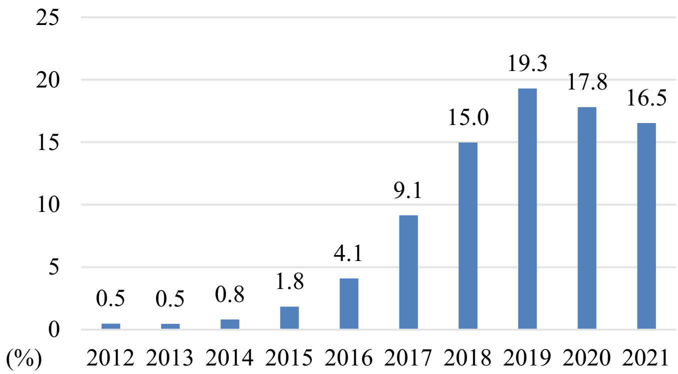

Fig. 23 Proportion of China's STEM education research in the past decade. *Source* Compiled from search results from CNKI

6.1 General Overview

Based on China National Knowledge Infrastructure (CNKI) database, the proportion of STEM education papers over all the Chinese educational papers published in a decade (2012–2021) are calculated and shown in Fig. 23. Overall, the proportion of STEM education-related topics is increasing constantly, showcasing a booming trend in the last five years.

The high-frequency keywords of STEM education research in China are identified as the "U.S.", "maker education", "science education", "basic education", "core literacy", "teaching model", "interdisciplinary", "artificial intelligence", "curriculum design" and "teaching design" (Table 3). Further analysis with the cluster analysis shows that the STEM education research in China is dense and connected, without obvious branching structure (Fig. 24). The different research topics are interrelated and form nine major research clusters. After reviewing the literature within the clusters, three themes are emerged as follows: studies of international experiences, local practices and teaching models, and integration with maker education.

6.2 Focusing on International Experiences

There are many studies focused on reviewing the international experiences of developing STEM education, especially from US. These introductions of international experiences draw the developing trends of educational levels, educational settings and practices.

Firstly, in terms of educational levels, Chinese researchers have shifted their focus from K-12 to tertiary education. Since the National Science Board (2007) first stressed the development of STEM education across all levels (National Science Board, 2007), STEM education has been implemented in preschool, K-12, tertiary,

Table 3 High-frequency keywords of STEM education research in China from 2012 to 2021

Keywords	Frequency	Proportion in STEM education research	Centrality
U.S	50	9.31	0.26
Maker education	29	8.57	0.30
Science education	25	4.66	0.16
Basic education	12	3.54	0.09
Core literacy	12	3.91	0.07
Teaching mode	12	3.91	0.06
Interdisciplinary	11	2.42	0.09
Artificial intelligence	10	2.42	0.04
Curriculum design	9	1.86	0.03
Teaching design	9	1.68	0.09

Source Compiled from search results from CNKI

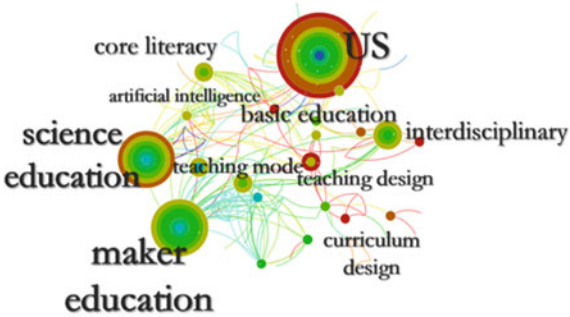

Fig. 24 Clustering view of STEM education research keywords in China from 2012 to 2021. *Source* Compiled from search results from CNKI

and vocational education (Ma & Cai, 2018). Chinese researchers first focus on basic education and review educational objectives, curriculum, assessment, and teacher training related to STEM education (i.e., Xia et al., 2016; Yin & Wang, 2017). The studies introduced the best practices on combining theory with practice, building social synergy, cultivating excellent teachers, and aligning K-12 education with higher education (Wang & Li, 2017) have been identified. In recent years there has been an increasing focus on STEM in higher education. Following similar analysis frameworks on K-12 education, scholars analyze tertiary STEM education in the U.S. (Lin & Zhuo, 2021; Ye, 2021), including STEM teaching models and training approaches in undergraduate and graduate phases (Liu & Zhuang, 2021; Xue & Wu, 2021). Meanwhile, researchers also pay a particular attention to the cultivation strategies of science and technology talents (Bai, 2020), and review mechanisms of quality assurance on STEM education at higher education levels (Li & Zhao, 2019; Wang et al., 2019).

Second, the focus on educational settings has shifted from school education to informal contexts. For example, Yang and Zhuo (2016) made an early introduction of how STEM education in informal settings in the U.S. meet students' intellectual, social, and emotional development needs. The convening of the Symposium on Informal STEM Education in 2014 and the release of the keynote report, *STEM Learning Is Everywhere: Summary of a Convocation on Building Learning Systems* (National Research Council [NRC], 2014), marked the informal STEM education as a new focus in the U.S. Later, the evaluation and indicator system of off-campus STEM education outcomes has also attracted Chinese researchers' attentions (Chen & Liu, 2017; Zhao et al., 2019).

Third, the focus has shifted from curriculum and instruction to policies and socio-cultural backgrounds. Previous research focuses on how to integrate STEM into national curriculum standards, textbooks, classroom teaching and instructions (Cheng & Zheng, 2015), and school systems (Li & Zhao, 2014). Researchers introduce STEM education strategic plans in the U.S. (Ji, 2016; Jin & Hu, 2017) and interpret them from an educational sociology perspective, discussing the global competitiveness (Zhang et al., 2020). This macro-level research interest aims to provide insights for China's indigenous theoretical construction and practice innovation.

6.3 Exploring Local Practices and Teaching Models

Recent research also shows scholars' interests on teaching and learning of STEM in the Chinese context. Most STEM education research in China is nested under science education research field, and align with the educational reforms in China.

First, STEM education practice at the secondary education level in China serves the purpose of 'core-literacy' oriented educational reform. Chinese researchers regard STEM education as a new strategy of science education with integration and concreteness (Li, 2022). For example, Cui et al. (2017) and Zhang et al. (2017) identify the unique values of STEM education for core literacy, such as setting an authentic context for knowledge building, improving problem-solving skills, and critical thinking development. Moreover, by placing STEM education under the vision of China's science education reform, researchers systematically explain the role of STEM education in facilitating the cultivation of high-quality science and technology talent in China (Tan et al., 2015). Chinese scholars intend to view STEM literacy from a comprehensive perspective, with particular focus on developing integrated knowledge, skills and attitudes for twenty-first century talents (Song et al., 2021), as well as transferrable skills (Lei et al., 2021; Wang et al., 2020). By contrast, international researchers advocated STEM education for both comprehensive practices and discipline-based education. For instance, Council of Canadian Academies (CCA, 2015) defines STEM competences include basic subject knowledge, practical skills and cutting-edge knowledge. Tumbarello (2013) underscored the STEM literacy includes solving STEM-related issues at individual, social, and global levels.

Second, interdisciplinarity is a core characteristic of STEM education in China. Researchers highlight the development of STEM-integrated courses in curriculum design, which emphasis on using interdisciplinary knowledge to solve the authentic problems in real world (Feng, 2016; Li & Lv, 2021). Students are expected to engage in knowledge integration and problem solving effectively (Dong & Zhuo, 2019). With interdisciplinary concepts at the core, scholars make efforts to eliminate disciplinary separation and build bridges in teaching practice (Cao, 2018; Qin & Fu, 2017). For example, Li (2019) proposes interdisciplinary research to support knowledge building and the consistent teaching, curriculum design and assessment. This trend in China is consistent with integrative STEM education globally, coinciding with the "interdisciplinary" and "problem and project-based contexts" trends in "decentralized-unified" continuum of STEM education as constructed by Nadelson and Seifert (2017).

Third, researchers focus on different approaches in delivering STEM in science education. Commonly advocation for project- and problem-based learning strategies (PBL) (Dong & Sun, 2019; Shen, 2018) and inquiry-based teaching (Zhang et al., 2017). Project-based learning has the advantage of simulating expert research in the process and focusing on the practical application of what have learned (Sawyer, 2014). Chinese researchers used PBL as a bridge between subject content and problems in reality, serving as an important pathway for STEM education delivery (Zhou et al., 2016). Moreover, along with the advocacy of "future literacy" for citizens in the digital age, Chinese STEM education adapts to the digital age and cultivate students' STEM literacy and innovative practical ability accordingly (Wang, 2015), promoting the use of intelligent technology to empower STEM education innovation (Zhong et al., 2019).

Fourth, Chinese researchers recently advocated the expands of STEM practices on building collaborative STEM ecosystem (Fu & Liu, 2016; Zhu & Lei, 2018) and equal accesses issues. However, while the international community focus their research on equal opportunities of STEM education in terms of gender bias (Weeden et al., 2020), ethnicity and social economic status (Weis et al., 2015), Chinese scholars (i.e., Li et al., 2020a, 2020b; Shi & Zhao, 2020) in 2020 started to address the problems of STEM education in the under-developed area in China and unbalanced development between urban and rural area (Xu et al., 2021).

6.4 Research on Integrating STEM Education with Maker Education

Following the trend of educational reforms using information technology, Chinese research on STEM education shows an emerging trend of integrating maker education in recent years. Chinese researchers have been intensively studying the motivations and foundations for integrating and promoting maker education and STEM education.

At first, maker education and STEM education were relatively independent; their characteristics and drawbacks have been discussed in depth by Chinese researchers.

According to Meng et al. (2020), maker education is featuring the use of technical tools and equipment in project practice and often pays little attention to scientific concepts and principles. STEM education, as a typical interdisciplinary science education pattern, is deeply involved in scientific understanding, while the integrated application of emerging technological tools in teaching remains insufficient (Meng et al., 2020). Yang and Ren (2015) point out that, although the two modes are of different origins with different focuses on teaching methods and outcomes, they both aim at cultivating thinking skills and developing comprehensive literacy. They both emphasize real situations and active student engagement. The integration of STEM education and maker education from the perspective of constructivist teaching theory has been recognized by the global education community. For example, Halverson and Sheridan (2014) believe that such an education model that reorganizes disciplinary learning and technology application is of value to students' deep learning and development from the perspective of "learning by making". Based on this consensus, Chinese scholars explore the integration and complementary development model of STEM and maker education. Maker education's emphasis on creation and output provides an effective supplement for STEM education; thus, STEM education can evolve with the support of the rich media and technological resources of maker spaces. On the other hand, STEM focuses on systematic knowledge, which provides a theoretical foundation and skill base for the cultivation of innovative talents (Wang et al., 2016) in maker education. For example, Liang and Zhao (2017) claimed that STEM's focus on multi-disciplinary integration and the idea of project-based learning can guide the innovative development of teaching activities in maker space. The extension of STEM education's boundaries and its integration with other education patterns highlight the Chinese characteristics of STEM education development. However, the integration with maker education also brought unique challenges for STEM education in China. Du (2021) raised the awareness of the value of STEM education in utilitarianism and excessive marketization context in China.

7 National Policies

The development of STEM-related fields has been considered as the key to constant innovation, economic growth, and international competitiveness. Most developed countries and economies have systematically implemented STEM education policies to meet their strategic demand for a highly skilled workforce. This section briefly reviews the STEM education policies in the U.S. and Europe, and then introduces the China's STEM education policies.

7.1 STEM Education Policy in the U.S. and Europe

The U.S. as the global pioneer in STEM education, has been extensively studied and researched by others. Since 1986, the U.S. has issued a series of policies and strategies to promote the STEM education practices, with two distinctive features. First, in the U.S., the science related departments, such as the National Science Board (NSB), the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA), have partnered in the development and implementation of STEM education policies, ensuring the professionalism of its educational content. For example, NSF issued *Undergraduate Science, Math and Engineering Education* report (NSF, 1986), also known as *Neal Panel's Report*, in which STEM education is mentioned for the first time. Second, the U.S. policies on STEM education are tightly tied with its national competitive strategies. In 2015, the strengthening of innovation capabilities and the development of educational technology is reaffirmed in the new version of *New Strategy for American Innovation: Creating Shared Prosperity* (shortened title, *New Strategy for American Innovation*). In December 2015, President Obama signed *Every Student Succeeds Act (ESSA)*, explicitly identifying STEM as key to educational progress. The U.S. also established the Committee on Science, Technology, Engineering, and Math Education (CoSTEM) which is dedicated to coordinating national STEM development strategies. The White House released two 5-year plans for STEM education in 2013 and 2018 consecutively (National Science and Technology Council, 2018). The U.S. Department of Education and American Institute of Research released *STEM 2026: A Vision for Innovation in STEM Education* in September 2016 (Tanenbaum, 2016), identifying the development of STEM education in children's primary education phase as one of eight challenges to achieve the educational visions of the next decade. In 2022, the U.S. Department of Education launched "YOU Belong in STEM",[12] an initiative to galvanize the broad STEM education ecosystem for all young people from Pre-K to higher education. With supportive policies, the development of STEM education in the U.S. has realized "vertical extension" from kindergartens to universities and "horizontal expansion" in the cooperation among STEM schooling, society and communities.

The European Union (EU) has also actively issued policies and guidance for its members promoting STEM education. In response to its problem reflected in PISA test, namely the shortage of talents in STEM fields, and public skepticism about scientific and technological development, the EU STEM coalition has been established to support strategies and plans for the advancement of STEM education in member states. *The Framework for Science Education for Responsible Citizenship* published in 2015 by the European Commission underscored the cultivation of students' scientific literacy; and in 2017, *School Development and Excellent Teaching for a Great Start in Life* (European Commission, 2017) was issued to vigorously advocate STEM education development. In 2019, the European Commission published *Science and Scientific Literacy as an Educational Challenge* (European Commission, 2019b), providing guidance to member states in science education policies

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formulation. Based on the continued strategy of lifelong learning and the digital education development plan, the document highlights the development of interdisciplinary STEAM education at all school levels (European Commission, 2019b). Different from the U.S., the EU focuses more on enhancing positive images of science and reforms educational assessments to attract young students to enroll in STEM fields. In 2020, *Assessment of Transversal Skills in STEM (ATS STEM)*, an innovation policy pilot project supported by the EU (Butle et al., 2020), implemented in eight EU countries, involving 12 educational institutions and governmental organizations. The German government has intensified efforts in vocational education and paid attention to students' interests and career so as to meet the STEM talent shortage in the industry 4.0 era. In 2019, German government released a new STEM action plan, *MINT in the future: BMBF's MINT Action Plan* to improve its vocational education in the new era (Federal Ministry of Education and Research, 2019). The U.K. emphasizes students' learning of math and science subjects, highlighting the rise of STEM career awareness and the development of STEM culture in elementary schools.

With regards to national policies on STEM education, both the U.S. and the EU focus on developing an interconnected STEM education ecosystem. For example, implementing STEM education policies in the U.S. involves cooperation with governments at all levels on resource integration, teacher training and information platform construction, as well as the engagement of under-represented groups (National Science Board, 2022). The German government has issued STEM education plans to build an "education chain" to integrate social resources, teacher training, school education, and employment. The plans also encourage and support the involvement of youth, women, and other minority groups to participate in STEM fields.

7.2 *STEM Policy at Secondary Education Level in China*

To meet the demand for science and technology talents to promote national development and enhance the country's international competitiveness in science and engineering field, China has issued a series of STEM-related education policies to strengthen the STEM workforce, especially on innovations, at both secondary and tertiary levels.

7.2.1 Developing STEM with Education Informatization

Developing students' STEM competence at a young age is crucial for cultivating innovation talents. At the secondary education level—the "critical phase" of STEM education, STEM education policy is an important component of the overall education modernization strategy in China, which ensures relevant infrastructure development. In particular, the development of STEM education has been aligned with the development of IT and AI.

The development of STEM education in China has synchronized with education informatization in China. The country's 13th Five-Year Education Plan for Informatization (2016–2020) issued by MOE in 2016, which required the exploration of new educational strategies. "Some regions with good conditions should actively explore the application of information technology in new educational strategies such as interdisciplinary learning (STEAM education), and maker education (MOE, 2016b). With regards to STEM education, the policy particularly encourages engineering and technology. In January 2018, MOE officially classified 3D design, open-source hardware, robotics programming, and AI into the new national curriculum standards and made them compulsory for high school students. In May 2018, MOE issued Education Informatization Action Plan 2.0, pointing out the urgency to shift from tool-based thinking to an artificial intelligence mindset (MOE, 2018b). In November 2019, MOE unveiled Guidelines on Strengthening and Improving Experimental Teaching in Elementary and Middle schools, which further advocates the integration of programming education and artificial intelligence education with teaching and learning in class.

The related policies also include developing an optimal educational environment for STEM education. In July 2016, MOE issued *Guidelines on Further Improving Educational Equipment in Elementary and Middle schools in the New Era* (MOE, 2016c), which clarifies the government support for the construction of comprehensive laboratories, characteristic laboratories, and educational maker spaces. In November 2019, MOE further issued *Guidelines on Strengthening and Improving Experimental Teaching in Elementary and Middle schools*, aiming to improve students' observation, practical, creative thinking, and teamwork skills (MOE, 2019b). It also indicates that elementary and middle schools should focus on the integration of experimental teaching with multidisciplinary education, programming education, maker education, artificial intelligence education, and social practice. The national policies also regulate the teaching and learning time of STEM activities in schools and encourage the inclusion of STEM activities in formal curriculum and after school activities. On the one hand, it is recommending STEM in after school activities. In February 2017, MOE issued *Guidelines on After-school Services for Elementary and Middle School Students*, encouraging schools to carry out science activities, establish student clubs and hobby groups (MOE, 2017b). On the other hand, elementary and middle schools are encouraged to integrate STEM into regular curriculums. MOE has released new standards for curriculum in junior and senior high schools since 2017, and in junior high schools in 2022. The new curricula clearly state the core literacy for STEM-related subjects, requires the inclusion of interdisciplinary content in lessons, and encourages the cultivation of innovation ability.

7.2.2 Improving STEM Teaching Quality in Middle Schools

Teachers are important to education as being one of the sources of its thriving development. However, China's STEM education suffers from an insufficient number of qualified STEM teachers. According to a survey of teachers in Grade 8 (Tian et al., 2021), only 64.4% of biology teachers have biology teaching qualifications and only 54.9% of geography teachers hold degrees in geography, while physics teachers with physics teaching qualifications accounted for 84.8%. Geography teachers in middle schools remain insufficient and classes are often taught by teachers responsible for other subjects, according to the *Report on Development of China's Science Education (2019)* (Wang & Li, 2020). Moreover, 52.7% of teachers have not participated in teacher training since 2010. The report shows the lack of pedagogical content knowledge (PCK) and scientific content knowledge among STEM teachers, who also lacking sufficient in-service training. Most STEM teachers have been teaching science programs for less than five years, indicating the high mobility and lack of stability of STEM teaching force. In addition, it has been found that there are significant differences between urban and rural areas in curriculum resources, teaching, and professional development (Hu et al., 2017).

To improve the quality and quantity of STEM teachers and bridge regional and urban–rural gaps, a series of targeted policies have been published by MOE. For example, since 2010, MOE has been implementing the National Teacher Training Program, which seeks to improve the teaching quality and skills of teachers including those who teach science (MOE, 2010). The professional and information literacy of science teachers in Chinese schools have been significantly improved, especially those in rural and remote areas. The *Outline of the National Plan for Medium- and Long-Term Education Reform and Development (2010–2020)* released in 2010 emphasizes enhancing teaching quality, to "strictly manage teacher qualification, improve teacher quality, and strive to develop a proficient and energetic teaching force with noble characters, professional skills and reasonable structure that is of high-quality" (the State Council, 2010). MOE issued *Curriculum Standards for Teacher Education (Trial)* in 2011 and *Professional Standards for Middle School Teachers (Trial)* in *2012*, representing measures in policy to promote the development of professionalization of the middle school teaching workforce and improve the quality of teacher training. At the beginning of 2018, Chinese government issued *Guidelines on Comprehensively Deepening the Reform of Teaching Force Development in the New Era*, outlining a comprehensive blueprint for the development of teaching force, with emphasis on the need to "comprehensively improve the quality of teaching force in elementary and middle schools" (the State Council, 2018). In May 2021, MOE issued *The Standards for the Professional Competence of Secondary Teachers (Trial)*, aiming to further advance the subject development of teaching and improve the quality of those major in teaching, thereby enhancing the ability of teachers from the very beginning (MOE, 2021b). In 2022, MOE issued specific requirements to strengthen teaching quality in basic education levels (MOE et al., 2022), including STEM fields. In addition, in order to expand the supply of teachers in underdeveloped areas in central and western China (Xi, 2021), nine ministries jointly launched the

Targeted Training Program for Outstanding Teachers in Less-developed Areas of Central and Western China (referred to as the Outstanding Teacher Program) in July 2021. It is targeted to cultivate nearly 10,000 undergraduate students majoring in teaching every year for 832 poverty-stricken counties and their peripheral areas in central and western China.

7.3 Reform of Undergraduate STEM Education in China

In the last two decades, China has experienced rapid socio-economic transformation, which has led to increasing demands for updated knowledge and skills in the labor market. To meet the national demand for STEM talents, China has carried out workforce development reforms, including the Young Talent Program to cultivate top-notch talents in basic disciplines and the emerging engineering education (3E) for outstanding engineering aptitude.

MOE along with other ministries jointly launched the Young Talent Program in 2009 to offer special programs for gifted young students in STEM fields. In 2018, six ministries including MOE issued *Guidelines on the Implementation of Young Talent Program in Basic Disciplines 2.0*, also called the Young Talent Program 2.0.[13] This program has been expanded to broader disciplines including social sciences and extended support to more universities. Among the expanded disciplines, the crucial areas such as intelligent technology, new materials, advanced manufacturing, national security, as well as humanities and social sciences were emphasized (MOE et al., 2018a). More training centers have been established from 2019 to 2021. These centers served as important platforms and formed a world-class system for developing top-notch talents. After a decade of practices, in 2020, MOE issued *Guidelines on the Pilot Reform of Enrollment of Basic Disciplines in Universities and Colleges*, also known as the *Strengthened Basic Discipline Plan.*[14] The plan is deeply connected with the Young Talent Program, which works together to reform the admission system of STEM fields, including math, physics, chemistry and biology (MOE, 2020b).

In response to the accelerated development of the new industries, China has actively promoted 3E since 2017 which refers to emerging or emerged subjects in engineering. It aims to cultivate outstanding innovative engineering talents who can adapt to the changes for future industries, and represents the latest development direction of the industries. In engineering fields, it is found that most of the college graduates in China, after years of study, fail to apply what they have learned in real life, while many enterprises in the new industries argue that the biggest problem they face is a talent crunch (Wu et al., 2017). In 2018, the *Guidelines on Accelerating the Development of Emerging Engineering and Implementing the Cultivation Program of Outstanding Engineers 2.0* was issued to address the problems of engineering

[13] http://en.moe.gov.cn/news/press_releases/202205/t20220527_631451.html.

[14] https://english.www.gov.cn/statecouncil/ministries/202001/16/content_WS5e1fbffcc6d0891feec02516.html.

courses. It states that "China aims to have more than 20% engineering programs be international qualified in five years, and forms world-class engineering systems with Chinese features. Specifically, China aims to build a number of high-level science and engineering universities, jointly owned industry and future technology colleges and institutes, emerging engineering disciplines for the industry with great demand. It is also going to offer the new curriculum representing the latest progresses of industry and technology; as well as professional teaching force with strong practical skills." (MOE et al., 2018b) Through the measures above, China seeks to update its engineering education in the new round of scientific and technological revolution and industrial changes, and improve students' abilities as part of the initiatives to make significant advances in implementing the national strategy and promoting regional development.

8 Summary

STEM education has attracted global attention over the last few decades and become an indispensable part of national educational reforms. This chapter reviews the development of STEM education in China and the world. Although there are different definitions attached to the concept of STEM education to serve various educational goals, this chapter focuses on workforce development in the STEM fields, at both secondary and tertiary educational levels. Excellence indicators of STEM education have been proposed to analyze across 10 countries to depict the features of excellent STEM education. Both the highlighting data and excellent indicators confirm China's achievements on producing large scale of STEM graduates and academic achievements. However, the data also highlighted the need to reform STEM education at secondary education level to inspire students' interests, improve their STEM learning efficiencies, and enhance STEM career interest. The best practices and inspiring stories of STEM education in China are focused on attracting young students to STEM fields, which is one of the global challenges in STEM fields. STEM education in China has shifted from introducing and learning experiences from other countries to developing with Chinese own features. Both the practices and policies are consistently organized and designed around the national focus on preparing a strong, innovative STEM workforce. Relevant enrollment and learning programs reforms encourage young students to actively participate in scientific innovations. In particular, the development of STEM education in China, along with education informatization, focuses on ICT-related fields and utilizes information technology to support reform. STEM education practices in China also place an emphasis on scientists' engagement in teaching and learning.

The global comparative data are compiled to highlight the process and outcomes of STEM education in China. They indicate that China has achieved stronger STEM outcomes at both secondary and tertiary levels than other countries. However, the ability to solving problems with knowledge and skills in STEM disciplines still need to be improved in China. Chinese secondary students spend much more time in schools compared to their counterparts in other countries, while the proportion of Chinese STEM teachers with master's degree is much lower than that of other countries. Students which receive STEM education in China should improve their learning efficiency at secondary education level and STEM teachers should improve their professional competencies. One way to ensure the improvement of STEM education in China at the secondary education level is to improve the teaching quality. On the one hand, in-service training should be strengthened to update and improve STEM teachers' pedagogies, methods and skills. On the other hand, with the premise of education quality, the scale of STEM full-time master's in education shall be increased significantly, as well as expansions of in-service STEM teachers pursuing master's degrees. This is reflected in China's latest educational policies.

Excellence indicators of STEM education show, among the 10 countries, China achieves the highest total score. But the size of Chinese research and development personnel is the smallest among the 10 countries, and China ranks 5th in the middle school students' STEM career interest. This indicates that, although there is a large number of STEM graduates in China, few of them are likely to devote themselves to research and development. Meanwhile, ROK enjoys largest workforce in R&D among the 10 countries. This result is consistent with previous research, such as *EngineeringUK*, which shows both the enrollment and attainments affected the STEM graduates (Armitage et al., 2020). In China, it is particularly important to raise students' STEM career awareness and depict the whole picture of STEM career to students, thus laying a solid foundation for future engagements in STEM-related professions.

To address the global challenges of inspiring young students and attracting talent into STEM fields (DeWitt et al., 2011), this chapter highlights best practices and inspiring stories from China for global reference. To attract young talents to STEM fields, especially basic discipline research, reforms have taken place in terms of enrollment and curriculum across higher education. Top universities are actively engaged in practicing innovative teaching initiatives as well as developing talent training centers to implement the young talent programs. Moreover, it is important to promote students' interests in science and increase the relevance of science education to young students (Forsthuber et al., 2017). Scientists' engagement in teaching is proved to be an effective way to do so. But as international researchers have pointed out, scientists are not trained teachers and might not offer quality teaching and learning experience for young students as scientists' involvement is usually fragmented and subjective (Leshner, 2003; Llorente et al., 2019; Sheffield et al., 2021). In response, MOE in China works closely with research institutions and scientists, to make joint efforts to design curriculum and deliver teaching so as to ensure systematic learning and suitable content for young students. Furthermore, popular new media and the internet promote STEM education. Various science programs for public engagement are broadcasted online and attracted large number of audiences, including young students. These programs are efficient ways to attract young talents, and to expand access to young students to learn about various STEM career paths.

The latest research on STEM education in China focuses on learning lessons from the U.S. and implementing STEM practices in schools. Research in China shows a distinctive feature of combing STEM education with maker education with support of ICTs. Research interests of STEM education in China also extends to the tertiary level and informal education fields. Moreover, recent research put focus on STEM workforce development throughout the education system, from K-12 to higher education sector.

STEM education is closely related to national development strategies. Research shows that China has achieved high academic attainment in STEM fields, but low attainment in innovation. In response to this challenge, Chinese government has issued policies related to STEM education to develop students' innovation skills particularly in the areas critical to national development both at the secondary and higher education levels. Learning lessons from the STEM policies in the U.S., Chinese scientific institutions have actively collaborated with MOE to improve the quality of STEM education. However, compared with the U.S. and Europe, China's STEM practices still need to expand its programs to all levels of education, to enhance the programs' coherence across different educational levels, as well as to support a STEM ecosystem through the collaboration with scientific institutions, industries and the society.

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Chapter 10
Global Comparison of Student Mental Health

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Abstract Student mental health is vital to the growth of students and there have been continuous efforts made in improving student mental health in China. This chapter aims to introduce the overall Chinese students' mental health condition as well as the relevant practices and policies that support student mental health. Next, the highlighting data section compares the suicide rates and prevalence of psychological problems among Chinese students with other countries. The next section designs 10 indicators tapping on student mental health, campus safety, and school support for student well-being. Scores on these indicators for seven countries were computed, and the results show that Chinese students' mental health condition and support are roughly at the same level as other countries. Parallel to quantitative data, three successful national influential practices and three inspiring stories shed light on how Chinese educators and psychological professionals promote student mental health through various approaches. Finally, the latest research published in high-level Chinese academic journals and the latest leading national policies are reviewed to complement the comprehensive picture of student mental health in China.

Keywords Student Mental Health · Mental Health Service/Psychological Service · Mental Health Education · Psychological Support · School-Family-Community Collaborations

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1 Introduction

Student mental health is closely related to students' concurrent academic and social adjustment, and lifelong development. The current prevalence of psychological problems among students is at an unavoidable status. According to a national-representative survey, the percentage of elementary school students with emotional or behavioral problems is about 15.90% (Cui et al., 2021), and secondary school students about 19% (Cui et al., 2021). For college students, a meta-analysis study based on 560 studies from 2010–2020 indicates that the prevalence of general psychological problems among college students is about 23.50% (Chen et al., 2022a). A more comprehensive description of the meaning and background of these numbers can be found in the highlighting data section.

The overall student mental health condition is a challenging issue in most countries. At the same time, Chinese government has continuously made various efforts including issuing and implementing national policies aiming to improve student mental health conditions. The first policy that tapped into student mental health was issued in 1988, which points out that moral education in elementary and secondary schools should include "cultivating and training student moral sentiment and psychological quality" (Ma, 2019). The formal mental health education for students in China also started in the 1980s (Li & Gao, 2013). In February 1987, Zhejiang University started the first mental health course for college students in the country.

Over the last three decades, practices and governmental policies regarding student mental health promotion are integrated with student moral education (*daode jiaoyu*), well-rounded education (*suzhi jiaoyu*), health education, and mental health issues prevention and intervention. To guide practices, those policies covered various contents, such as defining the goals of mental health education by student learning stages and their internal modules, specifying the mandatory mental health curriculum requirement in higher education, stipulating contents that include mental health and adolescent psychology to be incorporated into the textbooks. Additionally, those policies set up excellent standards for mental health education in elementary and secondary schools, establishing objectives and management norms for the construction of psychological counseling rooms, and calls for building a mental health service model integrating schools, communities, families, media, and medical and health institutions.

The advancement in student mental health promotion practices goes hand in hand with the issuing of national policies on this content. These two complements facilitate each other. A few trends can be identified from the last three decades. First, mental health education has become increasingly important; originally mental health education content was incorporated into other subjects' curricula and later the government policies required specific mental health curriculum be set up at all school levels. Up to the end of 2021, many Chinese local governments at the provincial level provide specific guidelines regarding the mandatory mental health course time at the elementary and secondary school per week, with some even specifying the course syllabus.

A recent national policy calls for a mandatory mental health course set up at all Chinese universities.

Second, formal mental health education was previously considered the main approach to improving student mental health, however, today there is increased emphasis on the inclusion of psychological support to student well-being from teachers and other social institutions is equally emphasized. For example, there are supporting measures to reduce risk factors of mental illness by improving the social media and internet climate such as the *Qinglang* (which literally means "cleansed and uncontaminated") action. In another example that takes place after the piloting stage, all elementary and secondary schools in Shanghai started to implement the advisory system with all-teacher engagement in 2021 (Lin, 2021). Under the advisory system every student is matched with a schoolteacher advisor who can guide him or her to better navigate school life in all aspects. Additionally, family-school-community partnerships regarding student mental health have been emphasized more and more in policy over time (Ma, 2019). Policies facilitate the integration of school efforts in mental health education and support into the societal psychological service system. These latter two lines of practices will be described in more detail in the best practices section of this chapter.

The professional psychological service packages offered to students within schools have received increasing attention and overall service quality has been constantly improving. Based on the *2014 Characteristic School Standards for Mental Health Education in Elementary and secondary schools (Trial)*[1] (Ministry of Education [MOE], 2014), Chinese government has systematically evaluated and selected more than 800 schools with excellence in mental health education and practices. The standards include aspects of school psychology such as setting up specific school policies and management systems on student mental health, adequate financial investment, hiring professional school psychologists, providing counseling services under professional guidelines, as well as family-school-community partnership building in caring for student mental health (*ibid*). Schools with excellence in mental health education served as role models for other schools, and the overall psychological services offered in schools have become more professional and able to cater to more students. Following specific guidelines issued by the government in 2015 (MOE, 2015), more psychological counseling rooms in schools were constructed and group and individual counseling were conducted in many areas in China. In a recent investigation of 19 Chinese national mental health education role model areas, the average psychologist and student ratio is 1: 235 (Huang & Zheng, 2018). The psychological service provided to students also includes active prevention. Mental health screening systems for college freshmen have now been implemented and a four-level risk prevention network (university-department-class-dormitory) were set up in many colleges. These efforts may effectively reduce college students' suicide rates (Yang & Li, 2013).

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[1] This standard was included in the *Notice on Implementing the Plan of Striving for Characteristic Schools in Mental Health Education in Elementary and secondary schools* (MOE, 2014).

Finally, in recent five years, policies have been issued to ensure vulnerable groups (e.g., earthquake victims, left-behind children, migrant children) receive adequate care and support and specific issues such as campus bullying are tackled appropriately (Li & Gao, 2013; Ma, 2019). Efforts have been made to implement these policies, and scholars on student mental health also focus on these special groups or issues, aiming to offer better investigation and solutions. A detailed description of the latest research on student mental health will be provided in this chapter.

2 Highlighting Data

This section aims to share the most updated data from reliable sources and rigorous research on mental health education in China. Previously, people overestimated the severity of Chinese students' mental conditions because they drew conclusions based on non-representative samples and viewed the results without contextual understanding. Therefore, when similar data are obtained from other countries or at a global level, comparisons are put into context.

2.1 Suicide Rate in Chinese Youths

About 703,000 people die due to suicide every year in the world (WHO, 2021a). According to WHO's most updated statistics, suicide was the 4th leading cause of death among youth aged 15–19 years globally in 2019 (*ibid*). Suicide rates in China decreased dramatically from 2002–2015 (Jiang et al., 2018). According to the most updated WHO data, China's crude suicide rate per 100,000 in 2019 is 2.22 for older adolescent (15–19 years) and 4.26 for older adolescent and youth (15–24 years), which is lower than the six selected major OECD countries (see Table 1) (WHO, 2021b).

Suicide rate trends vary across times and subgroups. Based on aninvestigation, Chinese college students' suicide rate from 2008–2010 was estimated to be 1.24 per 100,000 students, which in general is much lower than the general population in the same year period (Yang & Li, 2013). To put this data into a global context, the college student suicide rate in the United States (U.S.) during 2004–2009 was about 7.0 per 100,000 students (Schwartz, 2011). The Chinese college students' rates seem to largely decrease over time. A study found that from 1989–1991, the suicide rate of college students in 23 colleges or universities in Nanjing was 16.22 per 100,000 students (Yin et al., 1993). Another survey of 8 colleges or universities in Beijing showed that from 1991 to 1995, the suicide rate of Beijing college students was between 9 and 24 per 100,000 students (Cui et al., 1998).

Although it would be misleading to attribute the decreasing suicide rate solely to better mental health care, as economic, environmental, and social factors also affect the rate (Huang & Saito, 2022). The decrease in suicide rate still indicates a positive

Table 1 Crude suicide rates (per 100,000 population) among older adolescent (aged 15–19 years) and youth (aged 15–24 years) in 2019 in seven countries

Countries	Older Adolescent crude suicide rates (15–19 year-olds)	Youth crude suicide rates (15–24 year-olds)
United Kingdom (U.K.)	1.91	4.94
China	2.22	4.26
France	3.95	4.11
Germany	4.70	5.99
Japan	5.09	12.44
Republic of Korea (ROK)	10.97	14.28
United States (U.S.)	13.92	14.40

Source Adapted from WHO (2021b)

sign in overall mental health improvement. Scholars estimated that mental disorders account for between 47 and 74% of the suicide risk (Bilsen, 2018). Lower rates of mental disorders and psychological distress are closely related to a lower suicide rate (Bridge et al., 2006; Shen et al., 2020; Zhang et al., 2020).

Suicide prevention efforts help account for the lowered suicide rate at Chinese universities. The four-level risk prevention network, namely universities, departments, classes and dormitories, has been established at many Chinese universities (Li & Yang, 2020). This network relies on class mental health committee members, student leaders, or student dormitory heads who pay close attention to challenges students face. College class advisors (*fudaoyuan*)[2] and/or head teachers (*banzhuren*) visit all students in their dormitories monthly. Schools/departments hold regular meetings to discuss students' mental health conditions and provide timely intervention and assistance to students at high risk of suicide (Li & Yang, 2020).

Additionally, since 2004, MOE has deployed a unified mental health census at colleges and universities that are directly affiliated to MOE (Shi et al., 2021). Chinese College Students' Mental Health Screening Scale and the Chinese College Students' Mental Health Network Evaluation System have also been set up under this census system (MOE, 2019). From 2016 to 2019, pilot assessments were carried out. By 2019, nearly 5 million college students had been screened for mental health assessment. These systematic assessments help to identify students at-risk earlier on and take appropriate action in a timely manner, which may also reduce the suicide rate among college students (*ibid*).

[2] College class advisors (*fudaoyuan*) is a specialized college staff position that takes various responsibilities on student affairs, including ideological and political education, guidance and management on student employment after graduation, life advising, etc. (Mi et al., 2015), but they do not work as counselors for mental health education. Usually, there is one class advisor per class at university.

2.2 Prevalence of Psychological Problems Among Chinese School Children and Adolescents

Even though the prevalence of psychological problems among Chinese school children and adolescents may seem easy to assess, accurately estimating this number is challenging. China is a country with various provinces and economic development levels. Local epidemiological surveys are conducted in certain areas, but results only represent local conditions, not the whole nation. This situation changed in 2021 when Chinese scholars published the first epidemiological survey based on a national representative sample including 73,992 individuals. This investigation provides a more accurate estimation of this seemingly simple number. Psychological problems include both general behavioral and emotional problems and mental disorders. This study systematically surveyed both conditions.

This nationwide survey applied a two-stage cluster stratified random sampling to identify participants for this study. Five provinces were first selected with a balanced consideration of economic development and geographical location. Within each area, stratified random sampling was used to select schools. A total of 81 elementary schools and 88 middle schools were randomly selected, and students in these schools were invited to participate in the survey.

In the first stage, the Child Behavior Checklist (CBCL) was completed by primary caregivers (usually the parents) and used to screen student mental health/well-being. This survey identified 14,653 high-risk children and adolescents. The estimated prevalence of behavioral and emotional problems was an overall 17.60%, with the older cohort (12–16 years) having a higher prevalence of 19.00% compared to 15.90% for the younger cohort (6–12 years) (Cui et al., 2021). In the second stage, a detailed clinical interview and diagnosis procedure was performed by trained clinicians to reach diagnostic decisions for a subset of participants (all high-risk participants and 5% of low-risk participants). Among them, 13,030 participants were diagnosed with at least one mental disorder. Overall and subgroup prevalence was estimated by employing sampling weights and poststratification weights to match the population distributions. It was estimated that the overall prevalence of one or more mental disorders was 17.50% in children and adolescents aged 6–16 years. Common psychological disorders' prevalence was also estimated and listed as follows: attention deficit hyperactivity disorder (ADHD) 6.40%; anxiety disorders 4.70%; depressive disorders 3.00%; tic disorders 2.50%; substance-related disorders 1.00% (Li et al., 2022). Whereas there was no difference between rural and urban groups, the prevalence of mental disorders was higher in boys, in older age groups, and in more developed areas.

A review based on 41 studies in 27 countries shows the worldwide-pooled prevalence of mental disorders in children and adolescents is 13.40% respectively (Polanczyk et al., 2015). World Health Organization (WHO) also releases 14% worldly prevalence of adolescents' mental disorders based on data from Institute for Health Metrics and Evaluation in 2019 (WHO, 2022). Compared with these data, the prevalence of mental disorders among Chinese children and adolescents seems

Table 2 Prevalence of depression and anxiety in children and adolescents during COVID-19 (2020–2021) across selected regions

Regions	Study N	Depression prevalence (%)	Study N	Anxiety prevalence (%)
China	15	21.60	13	15.90
North America	5	28.40	5	20.70
Europe	3	33.80	4	33.90

Source Adapted from Racine et al. (2021)

to be slightly higher than the global average. This 2015 study was based on surveys conducted at different times, so the comparability is quite limited.

In current studies, the COVID-19 pandemic becomes an inevitable environmental factor with a global scale and large effects on mental health. A 2020–2021 study taking place during the height of the COVID-19 pandemic may shed light on depression and anxiety symptoms of children during this time. (Racine et al., 2021). Racine and colleagues conducted a comprehensive search for studies reporting on child/adolescent depression and anxiety symptoms from January 1, 2020, to February 16, 2021, as well as unpublished studies in PsycArXiv. Based on a strict screening process, a total of 29 studies were included in the meta-analysis, and the prevalence of symptoms at moderate to severe levels in different regions were shown below (*ibid*). The authors compared conditions in East Asia, Europe, and North America. All studies included in the meta-analysis that focused on East Asia used samples from China; the table has been modified to reduce confusion. It should be noted that the existence of depressive or anxiety symptoms is not equivalent to these participants being diagnosed as having major depression or anxiety disorders. Still, the high prevalence of psychological symptoms globally is alarming. Even though student mental health condition in China seems to be roughly in the same range or even better than the global condition under certain situations, it should be noted that China is still a developing country and mental health conditions and its care system in certain areas are less developed. The detailed condition is beyond the scope of this chapter (Table 2).

2.3 Prevalence of Psychological Problems Among Chinese College Students

There is no equivalent study conducted on college students' psychological problems using a national-representative sample and a strict clustered-sampling method as the study introduced above. Two recent studies, however, may be used as a reference to help us better estimate the prevalence. One study was published in May 2022 that conducted a comprehensive literature review from 2010 to 2020 and finally selected 560 studies fitting the inclusion criteria for meta-analysis. This study found that in the past 10 years, detection rates for psychological problems for Chinese college students from high to low are estimated to be: sleep problems 23.50%, depression 20.80%, self-injury 16.20%, anxiety 13.70%, suicidal ideation 10.08%, somatization 4.50% and suicidal attempt without success 2.70% (Chen et al., 2022a). Another study was conducted in 31 provinces in China with a total of 8,447 college students; the commonly used screening tool CES-D and GAD-7 were used for this investigation. On average, 18.50% of the surveyed college students have tendencies toward depression, 4.20% have tendencies toward high depressive risks, and around 8.40% have tendencies toward anxiety (Wang et al., 2021a). It should be noted in this study that only questionnaires were used, and these prevalence rates cannot be equivalent to psychiatric diagnoses. Results should be interpreted with caution.

From the suicide rate to recent depressive and anxiety symptoms, the condition of Chinese students' mental health seems to be better than the compared countries. The authors in this chapter by no means intend to argue that Chinese students' mental health condition is satisfactory. Huge efforts still need to be made to reduce the suicide rate and prevalence of psychological symptoms and mental disorders among Chinese students. Chinese schools, under the guidance of governmental policies, have made and will continue to make great efforts in improving student mental health. For example, since depression is the mental disorder most closely related to suicide, the government issued a specific policy to guide local governments to explore and carry out comprehensive prevention and treatment of depression. In 2020, the National Health Commission (NHC, 2020) in China organized experts to compile the *Work Plan of Exploring Depression Prevention and Treatment Featured Service* and issued the *Notice on Exploring and Developing Featured Service for the Prevention and Treatment of Depression and Alzheimer's Disease.* In the *Work Plan*, the government established several important goals to reach by 2022. One goal seeks to increase the proportion of students who are equipped with knowledge of depression prevention and treatment to 85%. Another goal seeks to ensure that all high schools and colleges and universities should incorporate depression screening into student annual health examinations, create personal mental health profiles for each student, evaluate students' mental health status, and pay special attention to students with abnormal evaluation results. This policy is very specific and targets depression prevention with concrete steps and measurable outcomes, with the intention of decreasing the overall student depressive levels. Additional details on practices that have already been established and relevant governmental policies can be found in the following sections.

3 Excellence Indicators

3.1 Design

This section intends to design a series of excellence indicators to provide a snapshot of students' mental health conditions. These indicators are not diagnostic, but rather a pulse check that reflects an overview of mental health issues and concerns students face and the support they may receive from the schools. A "whole state approach" is employed to define these indicators, which emphasized that overall mental well-being is not just the lack of mental illness, but rather a combination of a low level of psychological symptoms and a high level of subjective well-being (DiLeo et al., 2022).

The design of the excellence indicators of student mental health is composed of three dimensions: student mental health, campus safety, and school support for student well-being. While the student mental health dimension includes a direct measure of students' overall condition, the dimensions of campus safety and school support measure the environmental factors that have significant impacts on student mental health (Brière et al., 2013; Etopio et al., 2019; Reinke et al., 2011), and therefore are included in the student mental health excellence indices.

Five indicators have been selected for the first dimension. Student mental health, life satisfaction and positive feelings directly show students' well-being, whereas meaning in life and resilience closely contribute to their well-being. Life satisfaction, due to its close link with happiness and healthy habits (Lyubomirsky et al., 2005; Park, 2004), is commonly selected as an indicator of well-being. For example, in OECD's 2019 survey of social and emotional skills focusing on 10- and 15-year-old students, life satisfaction is one of the three indicators to measure student well-being.

Positive psychology's world-famous PERMA model outlines five key components of well-being and they are positive emotions, engagement, relationship, meaning, and accomplishment (Seligman, 2012). Both positive emotions and meaning in life were selected to be key indicators in this chapter. According to the broaden-and-build theory, the experience of positive emotions will help people to broaden their novel thoughts, activities, and relationships, thus further building their personal resources and enhancing their health and fulfillment (Fredrickson, 2001). In a school context, positive affect is positively associated with motivation, self-efficacy, and engagement at school, and indirectly with academic achievement (King et al., 2015; Mega et al., 2014; Pekrun et al., 2002; Weber et al., 2016). Additionally, positive affect has been shown effective in reducing depressive symptoms and anxiety (Taylor et al., 2017). Finding meaning in life and sensing a clear purpose was found to be an important protective factor for adolescents' mental health across various cultural contexts (e.g., Brassai et al., 2011; Brouzos et al., 2016; Ho et al., 2010). For adolescents specifically, they are in a special period of physical and psychosocial changes and identity formation, and a sense of meaning indicates a better understanding of themselves and the world around them (Brassai et al., 2011), which may further contribute to adolescent psychological well-being (Kroger, 2007). Therefore, meaning in life is selected as one indicator of student mental health.

Regarding resilience, according to social cognitive theory, when students believe that they will succeed in the face of adversity, there is a greater possibility that they will set challenging goals for themselves and work harder and more persistently trying to achieve them (Bandura, 1977; Ozer & Bandura, 1990). In the long term, resilient students are more likely to reach their full potential and career aspirations (Bandura et al., 2001; Wigfield & Eccles, 2000). Contrastively, addictive behaviors bring serious challenges to students' concurrent mental health and long-term development. Addictive behaviors can take many forms such as online gaming, overeating, gambling, and substance use. People who have addictive behaviors often experience a loss of control even though they try to control certain behaviors (Marlatt et al., 1988). Since these behaviors become common nowadays (Deleuze et al., 2015), it is essential to set the low prevalence of addictive behaviors as an indicator of student mental health.

The second dimension focuses on campus safety as it is a key dimension of school climate. Compared to other aspects of school climate, safety is more closely related to student mental health outcomes (Bradshaw et al., 2014). This chapter selects three non-overlapping indicators that are commonly used to indicate campus safety. Featuring power imbalance (Woods & Wolke, 2004), bullying involves unwanted and negative actions in which someone intentionally harms another person (Olweus, 1993). Bullying can be physical, verbal, relational, and even virtual through online platforms and digital devices (Hinduja & Patchin, 2010; Smith et al., 2008). Physically violent and deviant behaviors such as fighting may be more life-threatening and caused by non-bullying-related peer conflicts. Therefore, two separate indicators are formed with one on the low prevalence of non-violent bullying and the other on the low prevalence of physical aggression. Evidence has shown that not-violent bullying can increase the risk of student mental health hazards such as depression and anxiety (Barchia & Bussey, 2010). According to a global survey based on 65 countries, verbal bullying is the most common form of bullying, and its effect on adolescent mental health might be the most negative (Man et al., 2022). *Exposure to p*hysical aggression may also lead to poor mental health such as depressive symptoms (Quiroga et al., 2017). Additionally, the analysis here set an independent indicator on student weapon carrying, as students who are threatened or injured by weapons have higher rates of suicidal ideation and attempts (Wang et al., 2018). This indicator is special as student weapon carrying caused threat or harm to both self and other's physical and psychological safety (Mukherjee et al., 2022).

The third dimension *school support on student well-being* can be shown in various aspects. The overall school climate and teachers' caring and attitudes toward students all matter. Among all the factors, the focus is on school support that has the most direct impact on student mental health in this chapter. The first indicator designed for this dimension is the existence of a mandatory mental health curriculum. Students who do not have official channels to receive mental health education may neither be fully aware of the importance of being mentally healthy nor equipped with adequate mental health literacy. A mandatory mental health curriculum ensures students learn the necessary psychological knowledge and skills to effectively cope with life challenges and maintain positive mental status. Finally, an adequate ratio of the school psychologist to the student can ensure students receive the needed psychological services.

3.2 Definitions and Sources

All the dimensions and indicators and their corresponding relationships are shown in Table 3. The indicator values are meant to reflect the excellency level of student mental health condition or practices, therefore, the higher the values, the better the condition. Compared with traditional psychology that focuses on pathology, positive psychology is a new field (Seligman & Csikszentmihalyi, 2000) that explores positive psychological qualities and states that may promote mental health (Luthans, 2002). This "excellence" focus of designing indicators matches the orientation shift emphasized by positive psychology.

To create comparable student mental health indices across countries, the raw data of PISA 2018 are downloaded and analyzed. The values of each country on life satisfaction, positive emotions, meaning, resilience, low prevalence of non-violent bullying, and low prevalence of physical aggression are from PISA 2018. Students aged 15 participated in PISA 2018 with 76.50% of these students coming from Grade 10, and the rest of the students coming from Grades 7–9 and 11–12. In most countries, Grade 10 is the first year in high school. To ensure data corresponding to students of different countries experiencing similar life transitions are comparable, the data analysis in this chapter includes a subset Grade 10 students to create various scores. For student weapon carrying, mandatory mental health curriculum, and school psychologist and student ratio, additional sources are used. The selection criteria of the data source are that the transformed values would be comparable at the national level.

Table 3 Dimensions and indicators of student mental health

Dimensions	Indicators
Student mental health	Life satisfaction
	Positive feelings
	Meaning in life
	Resilience
	Low prevalence of addictive behaviors
Campus safety	Low prevalence of non-violent school bullying
	Low prevalence of school physical aggression
	Low prevalence of student weapon carrying
School support on student	Mandatory mental health curriculum
	School psychologist and student ratio

Lastly, to compute values for readers to understand them easily, for each indicator, all the raw scores are to be transformed into a score on a scale of zero to 100, with the country on the best condition scoring 100, and the other countries' raw scores calculated proportionately to 100 to the transformed scores.

3.2.1 Student Mental Health

This section discusses five indicators of student mental health: life satisfaction, positive feelings, meaning in life, resilience, and low prevalence of addictive behaviors.

Life Satisfaction. Life satisfaction is "an overall evaluation that an individual makes about his or her perceived quality of life, according to his or her chosen criteria" (Shin & Johnson, 1978). PISA 2018 measures students' life satisfaction by asking students "Overall, how satisfied are you with your life as a whole these days?" Students answered the question on a 10-point scale where zero represents "not at all satisfied" and 10 represents "completely satisfied". This directly shows adolescents' self-perceptions about how satisfied they are with their own current lives.

Positive Feelings. PISA 2018 asks students to report how frequently ("never", "rarely", "sometimes", "always") they feel happy, lively, proud, joyful, cheerful, scared, miserable, afraid, and sad. In the chapter, following the practice of PISA 2018 selecting happy, joyful, and cheerful as the three items to create an indicator of positive feelings, these three item scores are also chosen to form the variable "positive feelings" by taking the average of the three. The responses from "never" to "always" are assigned values 1–4 in sequence. Higher scores indicate higher levels of positive feelings in daily life.

Meaning in Life. This chapter uses PISA 2018's definition of meaning in life as "the extent to which 15-year-olds comprehend, make sense of, or find significance in their lives" (Steger, 2012). PISA 2018 asks students to read the following statements: "My life has clear meaning or purpose"; "I have discovered a satisfactory meaning in life"; and "I have a clear sense of what gives meaning to my life" and then select "strongly disagree", "disagree", "agree", "strongly agree" to indicate how much they agreed with each statement. "Strongly disagree" is assigned value one, whereas strongly agree is assigned value four in PISA 2018.

Resilience. Resilience takes many forms. This chapter focuses on self-efficacy, the extent to which individuals believe in their own ability to engage in certain activities and perform specific tasks, especially when facing adverse circumstances (Bandura, 1977). PISA 2018 asked students to report the extent to which they agree ("strongly disagree", "disagree", "agree", "strongly agree") with the following statements about themselves: "I usually manage one way or another"; "I feel proud that I have accomplished things"; "I feel that I can handle many things at a time"; "My belief in myself gets me through hard times"; and "When I'm in a difficult situation, I can usually find my way out of it". The five corresponding item scores are averaged to form the variable "resilience", with higher scores indicating higher levels of self-efficacy facing adversity.

Low Prevalence of Addictive Behaviors. Addictive behavior is defined as "a repetitive habit pattern that increases the risk of disease and/or associated personal and social problems." (Marlatt et al., 1988). *Due to lack of globally comparable data, this chapter does not compute concrete indicator scores.*

3.2.2 Campus Safety

This section defines the three indicators of campus safety: low prevalence of non-violent bullying, low prevalence of physical aggression, and low prevalence of student weapon carrying.

Low Prevalence of Non-Violent Bullying. Non-violent bullying refers to bullying through verbal expressions or acts of non-direct physical harm. PISA 2018 asks students how often ("never or almost never", "a few times a year", "a few times a month", "once a week or more") during the 12 months prior to the PISA test they experienced the following conditions in school (the question also indicated that "Some experiences can also happen in social media"): "Other students left me out of things on purpose"; "Other students made fun of me"; "I was threatened by other students"; "Other students took away or destroyed things that belong to me"; "I got hit or pushed around by other students"; and "Other students spread nasty rumors about me". To capture the nature of non-violent bullying accurately, items on "left me out of things on purpose" "made fun of me" "took away or destroyed things that belong to me" "spread nasty rumors about me" are averaged to form the variable non-violent bullying.

Low Prevalence of Physical Aggression. The item score from PISA 2018 "I got hit or pushed around by other students" is used as the raw score for the low prevalence of physical aggression.

Low Prevalence of Student Weapon Carrying. Since other countries have strict laws prohibiting the access of weapons and weapon carrying of students, there are rare incidences of students carrying weapons to schools. It is reasonable to assume all the countries except for the U.S. had the best condition and their corresponding scores were set to be 100. As for student weapon carrying in the U.S., the statistics from the most recent U.S. national official report, *Report on Indicators of School Crime and Safety: 2020*, is used. This report was released by an institution under U.S. Department of Education: the National Center for Education Statistics (NCES), Bureau of Justice Statistics and Office of Justice Programs. In this report, about 7% of Grade 9–12 students in the U.S. reported that they had been threatened or injured with a weapon on school property during the last year, which means this type of behavior still affects students' daily lives. The percentage of students in Grade 9–12 who reported carrying a weapon anywhere during the previous 30 days is 13.20% in 2019 (Irwin et al., 2021). Therefore, it is a rough estimation to assign the score by using 100 minus 13.2 to indicate the low prevalence level of student weapon carrying in the US. In the future, if there are investigations across countries to estimate the student weapon carrying rate, data from such type of investigation should be used.

3.2.3 School Support for Student Well-Being

This section discusses two indicators measuring school support, namely mandatory mental health curriculum and school psychologist student ratio.

Mandatory Mental Health Curriculum. Based on our search for the seven selected countries, three countries (China, Japan, and United Kingdom [U.K.]) have already set out the national policies on mandatory mental health curricula. In China, the policy *Guide of Integrating Life Safety and Health Education into Elementary and secondary school Curriculum* issued in 2021 requires five areas of life safety and health education to be incorporated into the textbooks, of which Area 3 is mental health, and Area 2 contains adolescent psychology (MOE, 2021a). Prior to 2021, most of Chinese provincial governments have already specified mandatory mental health weekly course hour at the elementary and secondary school. Chinese government also requires at least one mandatory mental health course in higher education institutions (HEIs) for college students (MOE, 2021b). For Japan, under the Japanese government's new curriculum guidelines, senior high school students will start to learn prevention and coping methods for mental illness since 2022 (Ojio et al., 2021). In 2019, the U.K. government announced the introduction of a compulsory subject at school called "Relationships, Health and Sex Education" in both elementary and secondary schools. This subject includes two sections: physical health and mental well-being and relationships. This policy is supposed to be effective starting from September 2020. (Department for Education & the Rt Hon Damian Hinds MP, 2019; Mentally Healthy Schools, 2019).

For the U.S. and Germany, due to these two countries' government structure, there are no policies on mandatory mental health curricula at the national level. Three states (New York, Virginia, and Florida) in the U.S. have passed laws that require mental health education either in both elementary and secondary or only in middle schools (Hood, 2019), but there are no mandatory courses at the college level. Even though in some Germany states, there are courses on psychology at secondary schools, these courses are usually elective, fitting the requirement of completing course credits on social studies.[3] Finally, not much information can be found regarding mental health education in the school setting in France and ROK. Through the search for the latest academic papers on this topic, scholars in both countries all showed through surveys that most students had not experienced formal mental health education (Bezard & Rouquette, 2019; Chin et al., 2018).

[3] The first author together with a Germany-Chinese bilingual assistant had done a comprehensive search on the Germany school curriculum and state policies in the following states: Bavaria, Hamburg, Saxony and Berlin. By August 4th, 2022, no mandatory courses on mental health education or related policies can be found.

Based on the aforementioned information, this chapter assigns scores to each country according to the policies on mandatory mental health curriculum. The country with the mandatory mental health curriculum set up in all school stages will be assigned 100. This score is to correspond to whether there are elementary (20), secondary (35), and tertiary (45) mandatory mental health curricula either at the national level or at the average state level. The reason why different education stages have different weights is in correspondence with mental health prevalence and thus the importance of a mandatory mental health curriculum at different educational stages.

School Psychologist Student Ratio. School psychologists are professionals who "collectively provide individual assessment of children who may display cognitive, emotional, social, or behavioral difficulties; develops and implements elementary and secondary intervention programs; consults with teachers, parents and other relevant professionals; engages in program development and evaluation; conducts research; and helps prepare and supervise others" (Jimerson et al., 2007). In some countries, "school psychologist" only refers to a professional with a doctoral degree, but usually in the field and also in this chapter, a broader definition of school psychologist will be used. As long as the professionals provide the psychological services mentioned above, regardless of their education degrees and titles (e.g., counselor, educational psychologist, professional of educational psychology, psychopedagog, psychologist in the schools), they will be referred to as school psychologists.

There is only one available study that explored the school psychologist to student ratio across all countries using a systematic approach in 2008 (Jimerson et al., 2009), which made the comparison between the seven selected countries possible. Based on the raw scores of the ratios provided by the appendix in this study, an equation is applied to transform the raw score into new scores. Since U.S.' 1/1,506 is the maximum school psychologist-to-student ratio achieved among the seven countries, this value is set as the standard that corresponds to 100. The equation is written as $X_{\text{raw score}}/ (1/1{,}506) = X_{\text{new score}}/100$ to show the equal ratio between a country's statistics compared to the best condition in reality. This equation after numeric transformation is $X_{\text{new score}} = X_{\text{raw score}}*150{,}600$.[4] The higher the values, the closer a country's ratio is to the recommended standard.

3.3 Findings

The indicator scores in each dimension are calculated based on the method described above and arranged in the next three tables respectively (Tables 4, 5, and 6). The two indices in the last column of Tables 4 and 5 are calculated based on taking the average of all the corresponding indicators, and when displayed in the table transformed by the approach of setting the highest raw scores into 100.

[4] *Here means multiply in the equation.

Table 4 Scores of the four indicators on student mental health and the overall student mental health score in the seven selected countries

	Life satisfaction	Positive feelings	Meaning in life	Resilience	Student mental health indicator
France	100	99.26	100	95.47	100
Germany	98.7	99.01	97.41	97.78	99.54
U.S	94.56	100	92.68	100	98.10
ROK	89.95	99.02	95.14	96.07	96.32
China	90.97	97.9	96.3	94.98	96.31
U.K	87.31	90.82	90.23	94.19	91.85
Japan	85.88	86.28	92.17	85.11	88.53

Table 5 Scores of the three indicators of campus safety and the overall campus safety score in the seven selected countries

	Low prevalence of non-violent bullying	Low prevalence of physical aggression	Low prevalence of student weapon carrying	Campus safety indicator
ROK	100	100	100	100
China	92.78	96.31	100	96.36
Japan	95.47	93.58	100	96.35
Germany	91.2	96.39	100	95.86
France	91.9	94.39	100	95.43
U.K	87.1	91.02	100	92.71
U.S	88.09	93.24	86.8	89.38

Table 6 Scores of the two indicators of school support on student mental health

	Mandatory mental health curriculum	School psychologist student ratio
U.S	55	100
China	100	37.65
Germany	0	15.88
U.K	55	47.11
Japan	35	36.28
France	0	54.11
ROK	0	0.82

Notes The raw score regarding school psychologists for China was not available in the Jimerson study, therefore, the ratio of 1/4000 required by the recent Chinese national policy was used in the estimation here. The 1/4000 is a safe estimation: the current policy requirement on professional numbers are restricted to school psychologist providing practical psychological services at schools, whereas in the Jimerson study, professionals providing service at the communities or researchers were also counted

3.4 Discussion

For student mental health condition only, situations in the seven countries are not ideal, so all the raw scores are a little further away from the best condition.

Chinese students' mental health conditions seem to be at a similar level as other countries. Compared to life satisfaction and positive feelings, the presence of meaning in life (raw score, not shown directly in the table) is relatively lower for students from all seven countries. Value guidance and life education are closely associated with meaning in life. In the Chinese education system, it is recently emphasized in governmental policies that there should be mandatory life education courses and positive life value guidance infiltrated into the curriculum across various subjects (e.g., MOE, 2021a). These policies may potentially help students increase meaning in life.

Chinese students' campus safety conditions seem to be at a similar level as other countries. Even though the overall condition is good, bullying usually happens to a few individuals more frequently than the other students and causes severe negative consequences to those being bullied. This condition may not be fully reflected in the indicators. This is an area where consistent effort should be made to ensure there are fewer and fewer students being bullied and becoming victim of physical aggression and weapon threat/harm over time.

The conditions of school on student mental health support across the seven countries were far from satisfactory. All the countries have vast gaps between the school psychologist and student ratio and the recommended standard set by professional associations. It should be noted that the most updated recommended ratio number is now 1/500–700 (NASP, 2020). None of the countries are close to this standard. Chinese government has already set up policies on improving student mental health by specifying the recommended ratio is 1/4,000. Additionally, in a recent investigation of 19 Chinese mental health education role model areas which include 7,211,409 elementary and secondary school students in total, the average psychologist and student ratio is 1/235 (Huang & Zheng, 2018), which shows the feasibility of reaching the 1/4,000 in the future.

4 Best Practices

Different approaches have been adopted to promote student mental health education in China. Among these approaches, three types of practices have been widely applied and regarded effective in improving students' mental health, that is, strengthening the school-family-hospital partnerships, creating an advisory system with all teachers engaged in student mental health development, and developing mental health hotlines (e.g., Zhou & Qi, 2022).

4.1 An Integrative Force: School-Family-Hospital Partnership

School-family-hospital partnerships is a well-known ecological practice that supports students' mental health in China. It was reformed from school-family-community collaborations for students' overall development. The collaborations requested three parties (school, family and community) to serve the needs of students' general development and academic performance from different but holistic angles. For example, to promote students' overall development through school-family-community collaborations, schools may provide family education and educational suggestions for parents, invite parents to school, and organize school-family-community social activities through family visits, school and community open days, and social practicums. Family is a crucial support network for individuals in Chinese culture (Xu et al., 2007). Hence, family takes a central role in student mental health support and practices were formed based on this emphasis on family. This becomes one important feature of Chinese mental health education. Hospitals, representative of the community, join in the mental health practice for students with the society's increasing awareness of students' mental health and the implementation of the national policy *Health China 2030* (please see the National Policies section for more information) by NHC.

The mental health institutes in China include mental health hospitals and departments of mental health affiliated with hospitals. Chinese people usually seek help from mental health institutes when they are mentally ill, where they can get medical and psychological counseling services. Though students can get treatment from such hospitals, they may not be the most ideal place for on-time intervention and diagnosis of students because of stigma. Students might be too young to seek help by themselves, which may delay their timing of diagnosis and treatment. Therefore, psychiatrists and psychologists from hospitals get connected with schools and families to spot student warning signs earlier, provide appropriate interventions, and create a psychologically friendly environment for students.

The family-school-hospital partnerships promote students' mental health mainly through, but not limited to the following five activities: mental health education and outreach services on campus, express lanes to professional services, training and support for teachers, family education, and academic teaching in hospitals.

4.1.1 Mental Health Education and Outreach Services on Campus.

Psychiatric and psychological professionals from the hospital enter the school campus to provide in-person mental health education lectures and outreach activities for students, parents, and school teachers. The common topics of lectures are adjustment at school, performance anxiety, parenting styles, etc. The outreach services on campus include mental health disorders screening and campus consultations. Mental health education and outreach services are held regularly on campus, especially at the beginning and end of the semester or before important exams. Through mental health education and outreach services on campus, students' mental health problems could be recognized and diagnosed early, and then their mental health difficulties could be appropriately treated (You, 2021). Furthermore, as psychiatric and psychological professionals appear regularly on campus, students, parents, and school teachers may experience less stigma and concerns to seek help when they experience mental health difficulties.

4.1.2 Express Lanes to Professional Services

After hospitals officially collaborate with schools, hospitals will provide express lanes for the students at that school. Usually, when Chinese people experience mental health difficulties, they need to spend time finding a mental health institute, scheduling an appointment through online platform several days or weeks before the appointment day or going to the mental health institute very early in the morning to get a same-day appointment scheduled. Moreover, Chinese parents with children who may be diagnosed with mental disorders are hesitant to visit mental health institutes because of stigma and fears, but express lanes reduce these psychological barriers for parents thus enabling students to receive in-time professional help. If students need psychiatric or counseling services, they can receive referrals from their school counselors for hospital-based services without spending time finding a suitable mental health services provider. Psychological and psychiatric professionals are able to communicate with school counselors or school teachers after receiving consent from students and their parents to gather additional information for diagnosis and treatment planning. To better support students while they are at school, online counseling services provided by the hospital might be available for the students at the school counterparts. Some students may be ashamed or forget to take psychiatric medicine at school. In response to this problem, psychiatrists may cooperate with the health teachers at school to help students take medicine on time at school. When students are in crisis (e.g., suicidal or committing self-harming), they can receive services from the hospital without waiting. When there is a crisis at school, the professional counseling staff from the hospital may offer suggestions and support for the school to handle the crisis.

4.1.3 Training and Support for Teachers

Despite the support directly provided for students, the staff from hospitals also provide training and professional support for school teachers and school counselors. On the one hand, school teachers and school counselors can consult with hospital professionals regarding students' problems, which helps them solve work challenges. On the other hand, the staff from hospitals provide training and additional support for them (e.g., teaching mental health education courses) to improve their psychological-related knowledge and skills to decrease their significant work burden. Some hospitals even provide opportunities for school teachers and school counselors to visit their inpatient and outpatient units, which further enhances their psychological professional knowledge and skills.

4.1.4 Family Education

Family education is an increasingly important focus in Chinese society. Many schools have already started to provide family education or parental training. After the psychiatric and psychological professionals from hospitals joined in the partnerships of family and school, they actively participate in family education and training. Family education usually addresses parent–child relationships, communication skills with children, and early signs of mental health problems. The goal of family education is to improve parents' relationships with their children and awareness of mental health problems, which impact students' mental health and psychological well-being.

4.1.5 Academic Teaching in Hospitals

The above four practices are mainly about how hospitals help school students, teachers, and students' families through the family-school-hospital partnerships. Indeed, the school also provides support for students in hospitals through academic teaching. Many students must stay in hospital for several days concerning their physical and mental health illnesses. Being distant from school, teachers, and their peers may make students feel disconnected and anxious about school and their academic work. With family-school-hospital partnerships, however, school teachers working as volunteers can enter inpatient units to teach and advise those hospitalized students about their academic learning. Being able to keep up with academic learning and communicating with school teachers, students' emotional well-being is stabilized and their adjustment back to school will be easier after they are discharged.

In sum, supporting students' mental health through ecological systems, such as school, family, and community, is a new trend in Chinese Education system to prevent and intervene students' mental health problems. The ecological practice is widely used due to two reasons. On the one hand, Chinese educators are clearly aware that students' psychological well-being cannot develop without a supportive environment. On the other hand, the national policy of "Three-Holistic Education" (*sanquan yuren)* advises cultivating students through all processes, all members, and all directions. Hospitals, a representative of community, take an important and leading role in students' mental health problems prevention and intervention by cooperating with school and family. But hospitals are not the only agency of community contributing to student mental health. More agencies in the community, such as art museums, community centers, are taking or are expected to take actions to partner with school and family to positively cultivate students' psychological development.

4.2 All Teachers Engaged in Students' Mental Health Development

With the implementation of the "Double Reduction" policy, an advisory system with all-teacher engagement to support student mental health development has been developed and piloted in Shanghai elementary and secondary schools from 2021. According to the system, all school teachers are matched with student advisees. The advisory system is developed because many Chinese students are found to experience mental health problems at young ages. The system expects advisors to identify, prevent and solve students' mental health problems through daily communications. If the students encounter mental health problems, the advisors assist students with referrals and access to interventions. Now, the advisory system with all-teacher engagement has been implemented in about 200 elementary and secondary schools in Shanghai. For elementary schools, this system is applied to some grades in need. For middle schools, the system covers all grades. For high schools, the system applies to all students and is integrated with life and career planning.

The duties of schoolteacher advisors include but are not limited to providing personalized suggestions for students' academic learning; supporting students' psychological development and life planning through daily communications and activities; and building connections with families to support students' general development. Many schools have specific requirements for schoolteacher advisors. In Shanghai Qibao High School, one of the earliest schools to implement the advisory system with all-teacher engagement in 1998 and selected as the National Model School for Mental Health Education, school advisors are required to complete six out of ten activities, which are as follows: read a book together with students, discuss research projects at least once with students projects, explore life planning with students, participate in an art activity, have a birthday lunch with students, conduct a family visit, invite students to the advisor's home, participate in students' class activity once, join in students' P.E. activities, and join in students' social activity once. Teachers can choose six activities according to their strengths and preferences, which will create an optimal mentoring relationship. The program is designed to encourage teacher advisors to accompany and care about these students, instead of managing or merely teaching students (Pan, 2021).

The system is also built up according to the philosophy of the "Three-Holistic Education" policy, where everyone contributes to student development. Therefore, the system requires every schoolteacher to be an advisor to several students and assigns every student an advisor. If some teachers are not suitable or qualified to be student advisors, they will receive additional training and assessment for the qualification. To support these teachers in becoming qualified advisors for students, Shanghai Municipal Education Commission published three handbooks of guidelines, addressing student–teacher relationships, family-school communications, and homework design. In addition to the handbooks, the Shanghai Municipal Education Commission also provides training for teachers and encourages districts and schools to initiate trainings.

To further develop teacher advisors' cultivation skills, the schools provide support for these teachers to receive psychological and counseling trainings. Because most school teachers studied Education, they are aware of the dearth of their mental health literacy and psychological skills. Many of these school advisors have attended trainings in school counseling and counseling skills, career and life counseling, and educational psychology. They apply counseling skills of listening, positive regard, and empathy in their daily communications with students and parents. Some of these school advisors have obtained national licenses in counseling and career development.

The advisory system with all-teacher engagement is deemed to be effective for students' psychological development. As surveyed in Shanghai Qibao High School, more than half of students considered the system "very necessary." (Pan, 2021) Students appreciated this system and have received significant advising in the fields of academic learning, moral education, psychological consultation, and career planning. As a student described, the teacher advisor cared about the students' psychological well-being. Once, the student did not perform well academically and started to become socially withdrawn in class. The advisor noticed the student's change and had several conversations with the student. With the advisor's patience, genuineness, and empathy, the student became more open and thoughtful, which made the student feel more confident and more connected with his peers. More importantly, the student became clearer about the future, which increased his motivation for academic learning (Pan, 2016).

During the pandemic, the advisory system with all-teacher engagement took a more important role. When students started to study online rather than in person at school, they were less connected with their peers and teachers in daily interactions. Their teacher advisors provided company and supported their feelings of connectedness. In Shanghai Qibao High School, the teacher advisors organized online support group sessions over the weekend, involving a group of students they advise, to chat about their experiences, concerns, and achievements during the pandemic. Though they were in quarantine, they were not alone (Qibao High School, 2022).

Overall, the practice of an advisory system with all-teacher engagement adds a new layer of support for students to promote their mental health. With the company and guidance of teacher advisors, students are more positive and thoughtful in their life, which also strengthens their resilience and decreases their mental health problems.

4.3 Immediate Tele-Support: Mental Health Hotlines

Mental health hotlines have been important channels for Chinese students to seek help when they experience psychological difficulties and crises. The first mental health hotline was set up over 10 years ago in China. Mental health hotlines are usually hosted by the government, universities, hospitals, and non-profit organizations. Early mental health hotlines in China were initially opened for crisis assessment and intervention. They usually have abundant resources for crisis referrals and direct connections with local mental health hospitals and counseling centers, which enable them to assist callers to access further support as needed. The hotlines then also provide one-time counseling and consultation services. Mental health hotline services are welcomed by the Chinese people because the services provided by the hotlines are free, accessible, confidential, anonymous, and professional. When people need help, they don't need to spend time finding a counselor or counseling clinics, they can make a call to the mental health hotlines at any time of the day to receive an immediate response and support from counseling professionals without any expenses, transportation time, and risks of being stigmatized.

To ensure professional services, professional psychological counselors and social workers joined to take calls and provide support. Furthermore, they organized experienced psychologists, psychiatrists, and psychological professors to provide training, supervision, consultation, and emotional support for the front-line tele-counselors. Most psychological professionals volunteer to work for these mental health hotlines. The hotlines welcome every person in China to seek help. There are also English-speaking hotlines available for foreigners living in China.

Due to the outbreak of the COVID-19 pandemic, a considerable number of mental health hotlines emerged to support Chinese people's mental health. Most of these hotlines were opened at the beginning of the pandemic and are working till now, such as hotlines hosted by Huazhong Normal University rooted in Wuhan, Hubei. Though many more mental health hotlines and professionals joined in mental health support during the pandemic, the demand for hotline services was tremendous when compared to pre-pandemic levels. To regulate and support the rapid expansion of mental health hotlines, NHC issued *Guidelines for Mental Health Support Hotlines (Trial)* in 2021. In the document, the goals, serving populations, principles, and requirements of the hotline equipment and counselors' credentials are specified. *The Guidelines* also illustrate the recommended framework, questions, and interventions for different types of calls to support the healthy development of the mental health hotlines (NHC, 2021).

To further eliminate student barriers to seeking help, several mental health hotlines for children and adolescents have been set up. The most well-known national adolescents' hotline is the 12,355 hosted by the Chinese Youth League. It was opened in 2005 and intended to provide counseling and legal support for adolescents. This 12355 hotline is also considered an important channel for the Chinese Youth League to hear adolescents' voices and provide corresponding support. Till now, this hotline has already served over ten million people as both a national hotline and being operated by local teams. For example, if an adolescent in Shanghai makes a call to 12,355, he/she will get connected with a local counselor. Counselors' familiarity with local resources enables help seekers to get appropriate resources and referrals. The hotline work team includes psychologists, legal professionals, educators, and media workers. This hotline services are not limited to adolescents, but are also available to their parents and friends. To better meet the increasing needs of adolescents, the 12,355 hotline launched an online platform in 2017. Advantages of using online platform are increased flexibility for both parties in terms of time and space, and decreased fears for adolescents to talk about their concerns with adults, described by officials from the Chinese Youth League Shanghai Committee. The successful launch of the 12,355 hotline and online platform has made a significant contribution to adolescents' mental health during the pandemic. As reported, 12,355 Shanghai has served about 10,000 people and provided one on one counseling services for about 4,000 people, from March 10th, 2022 to April 21st, 2022, during the COVID-19 outbreak in Shanghai (Xu et al., 2022). Other well-known hotlines include 12,388 by All-China Women's Federation, 962,525 by Shanghai Mental Health Center. A few well-known hotlines and their targeting populations were listed in Appendix A for readers' reference. To note, though some hotlines are set up for students, they are also open to students' parents, teachers, and friends.

Overall, mental health hotlines have been an essential alternative way for students to seek mental health help, especially for those who are not willing to communicate their concerns with their family and school teachers. Students can make calls, or just go to websites and social media to get an immediate response, which expands the supporting channels for students' mental health.

5 Inspiring Stories

Numerous people have contributed to the field of student mental health in China. The development of student mental health relies on the social environment, which involves their family members, teachers, and figures connected through community and society. The following three inspiring stories are selected not only because of these three figures' significant contributions to student mental health promotion but also because of their creative approaches in student mental health promotion.

5.1 Wu Rongjin: Forerunner with Students' Emotional Learning

Wu Rongjin, the Principal of Luwan No.1 Central Elementary School in Shanghai, China, has been devoted to students' emotional development for about 20 years. Wu started her career as a Chinese teacher in 1994. In 2004, she and her colleagues observed that some students in their school had trouble expressing themselves. Those students appeared comparatively selfish, uncaring, impulsive, and lacked resilience when facing challenges (Yang, 2021). Wu and her team were concerned about their students' emotional development. However, it was hard for them to get professional psychologists' help regarding the problem, because positions of school counselors and psychological teachers were not set up in their school 20 years ago. At that time, schools were not required to hire psychological professionals. MOE regulated that school teachers should integrate moral, aesthetic, and emotional cultivation into their daily teaching.

As so, she and her team started a course to promote their students' social and emotional learning. There was no existing model they could refer to at that time. Therefore, they developed a course of social-emotional learning from scratch. The course was initially a 15-min talk at noon in class, and then became a formal class addressing conflicts and troubles happening between classmates, such as class bullying and students' test anxiety (Jiang, 2021). This course taught these students coping skills, but more importantly, the class also promoted students' communication skills, caring attitudes, resilience, school adjustment, and positivity.

In addition to the emotional cultivation course for groups, Wu also designed an individualized intervention called the "Emotion Weather Sheet" for students. As a Chinese teacher, she assigned every student to work on their own "Emotion Weather Sheet" for homework in her Chinese class. In this sheet, the students rated their feelings with scores and recorded their feelings and thoughts in weekly journals. Wu would read these journals and respond to each of them on the sheet. One of her former students commented, "I have been using 'Emotion Weather Sheet' to record my feelings for 10 years. It was initially an assignment from Mrs. Wu, but later I persisted in it though Teacher Wu was not my teacher anymore. Writing down events and my corresponding feelings strengthened my awareness and expression of emotions and made my talent in music stand out. Also, through reflecting on my emotions every day, I have been fearless about failures. I became grateful, kind, and chill. The sheet is a treasure in my life." (Gong, 2021).

To further facilitate the students' individualized learning and social-emotional development, Wu led her school to develop cloud classes for students covering topics such as reading, regular subjects, and sports (Yang, 2021). In cloud classes, the students' learning behaviors, such as writing homework with an electronic pen on the pad, would be recorded for analysis. Though some students exhibit similar academic outcomes, their learning paths could be very different. With collected data on learning behaviors, the teachers could set up individualized education plans for their students. Through "Cloud Kitchen" (*Yun Chufang*), students could learn cooking to develop their living skills and responsibility for life. In P.E. class, students' health status such as health rates and fatigue would be monitored by "Cloud Watches". "Cloud Exhibitions" would highlight students' creations shown in other cloud classes (*ibid*). As Wu expected, the technology assisted the teachers to understand their students' talents, areas of growth, and interests. The cloud classes responded to students' individualized needs, which improved the "efficiency of education" and promoted the academic and psychological "growth of students".

Because of her contribution and achievements, Wu was honored by the central government as a Role Model of the Times. Wu is not a psychological professional but a Chinese teacher and school principal, she integrated students' social-emotional education into regular classes and homework. Meanwhile, she responded to students' individualized needs massively and creatively with the use of technology. After all, she was able to successfully promote the students' social-emotional development, academic progress, and psychological growth, because she cares about the students and always thinks about them with patience, love, and creativity.

Wu is an outstanding figure among teachers, but she is not the only teacher who contributes to students' mental health and psychological growth as a non-psychological professional. In China, many school teachers also try to integrate moral, aesthetic, and emotional education into their daily teaching. School teachers in China do not only teach academic knowledge but also think of their students with love and facilitate the students' psychological growth through their everyday teaching and interactions with their students.

5.2 Shi Lingzhi: "Love" Letters Writer

Shi Lingzhi has been a teacher for 33 years. During her career, she takes care of her students' psychological well-being through her genuine love. According to the report (Luo, 2021), Shi started to work at an elementary school in the countryside of Hunan Province in 1989 at the age of 18. While the school was destitute, she overcame living difficulties and was always thinking about how to help students understand knowledge better. Before she taught a Chinese course text about house lizards, she spent one night catching three house lizards and brought them to the class. Her young students were greatly excited. The observation experience helped students better understand that Chinese class. Working for the rural school for 11 years, Shi became more resilient and more empathetic with children. She established a foundation to continue her work for future students.

In 2000, she was assigned to a new school due to her teaching excellence. The new school was located on the margins of the city and taught many students from the countryside. Shi observed that the students from the countryside performed worse in academics than students from the city. She also noticed that many students at her school, especially students from the countryside looked timid, sensitive, and reticent. "I also feel hard when I newly came to this school." She then realized that students from the countryside might be experiencing some adjustment problems. (*ibid*).

"But students' mental health was not emphasized that heavily, compared to now. I wanted to do something for those students." She decided to learn psychology and soon obtained the national license as a psychological counselor. She was the first teacher in her school to really focus on students' mental health education. She set up formal counseling rooms, a mailbox to receive students' letters, and private chat rooms.

During the five years of the mailbox and chat room operation, she received more than 700 letters from students. Through those letters, students expressed their concerns, emotions, and hidden secrets. Every student who put their letter in Mrs. Shi's mailbox would receive a warm and genuine response. In 2004, Shi noticed a girl who transferred from a rural school. The girl stated in the letter that she was "small, dark, and talentless, like an ugly duckling." In her response to that girl, she articulated her appreciation for that girl, "Your handwriting is beautiful, which reflects your devoting attitude towards studying. Your words are touching, which reflects that you have a beautiful heart and excellent writing ability…" That girl responded by mail to Shi after 13 years, when she completed her study in Germany, “Before meeting you, I only imitated and looked up adults, but never seriously looked at myself. You taught me to appreciate myself so that I can be confident.” Shi has kept all the letters from her students and their parents, which fill two of her closets. (*ibid*).

In 2012, Shi resigned from her position as the vice principal and became a Chinese teacher in a new school. She found herself entrenched in administrative work and unable to deal with students’ requests efficiently. Being a Chinese teacher allowed her to “just … be a teacher (and) be with students” and to respond to students’ requests and help-seeking as soon as possible (*ibid*). After taking her new position, she wrote letters to her students every week, totaling over 1.4 million words. Her students and parents called her letters “love letters”. They are not only keys to students’ hearts, but also guides for parents. Shi recommended books about family education to parents and guided parents to educate their children. “She always tells us healthy personality development is more important than grades. She also helped us to know our self-growth is the best education for children.” A parent commented.

Like what Shi insisted, “Every student is worth being warmly treated, and every student could twinkle like stars.” Because of Shi’s contribution to students, especially rural students’ psychological well-being, she was awarded the 2021 Role Model of Teaching in Hunan Province. Shi like many Chinese teachers guide students with their love and instinct backed up by professional knowledge and appropriate skills. They learn psychology as needed, use their heart to listen to students instead of forcing students to grow upon teachers’ expectations, and focus on students’ development instead of academic outcomes.

5.3 Cao Peng: Art Nurtures Heart, Art Enlightens Hope[5]

Cao Peng, one of the most distinguished symphony conductors in China, is still actively working on his lifelong career for school students and autistic children at the age of 97, along with his family. From 1955 to 1961, Cao studied symphony conducting at the Moscow State Tchaikovsky Conservatory under the baton of renowned professor Leo Ginsburg. In Moscow, he witnessed how local people enjoy symphonies, which planted a seed in his heart to spread the beauty of Western symphony to Chinese people.

After he came back to China in 1961, Cao became the conductor of the Shanghai Symphony Orchestra. He observed that Chinese workers do not like the symphony because it was far away from Chinese workers’ lives. Then he adapted several Chinese pop songs to symphonies, which ignited Chinese workers’ passion and appreciation for the symphony. He then realized that music education would be necessary for Chinese children to develop their sense of music, which might add color to their lives. Delegated by Shanghai Municipal Education Commission, he started to partner with K-12 schools, and HEIs to provide music education for students. With students,

[5] This section is based on interviews with Cao Peng’s family and students.

he introduced the history and function of the symphony. He invited his orchestra colleagues to teach students musical instruments, build students orchestras, and took the deputy of the conductor of those orchestras. He created opportunities for those student "musicians" to recognize their musical talents and perform symphonies. Cao led his student orchestras to perform in concerts and won uncountable prizes in music competitions and festivals, nationally and internationally. Some famous student orchestras guided by him are the Shanghai Student Symphony Orchestra, and the student symphony orchestras of Shanghai Nanmo Middle School and Shanghai Jiao Tong University. At his late 90 s, he is still the conductor of the Shanghai City Symphony Orchestra.

Some of his students became professional musicians, and some of them view music as core to their life beliefs. Dr. Zhou Yifan, currently a 26-year-old ophthalmologist, started to follow Cao from kindergarten and attends orchestra rehearsals every week through K-12, college, medical school, and even now as a doctor. He is very grateful to Cao. "Mr. Cao is a significant role model for us. Without music or him, I don't know what my life would be… Playing music is not easy. Through my experience with him, I become experienced in overcoming difficulties, which made me never scared in my life… I hope to be as diligent, moral, and devoted as how Mr. Cao is." Guiding those young students to enjoy music, giving them the power to live positively and resiliently, and creating opportunities for those students to build hobbies and reach their potential beyond academics. Through music education, Cao ignited his students' love for music but also provided an untraditional way for school students to identify who they are, to move forward bravely, and therefore to have generally positive psychological well-being. "People who learn music won't be evil because they have pursuits in life." That is what Cao's students resonated with. For Cao's contribution to student development, he was awarded Special Contribution Award for Caring for Adolescent Development by the Shanghai Education Development Foundation in 2018.

Beyond contribution to students through music education, initiated by Master Cao, his family provided tremendous help to autistic children and their families. They started to provide music education for autistic children by setting up "Angel Confidant Salon." Though they are not professionals at autism spectrum disorder (ASD) intervention, their music education has had an unbelievable effect. According to the American Psychiatric Association (APA), one of the core symptoms of ASD is the deficit of social communication and social interaction (APA, 2013). Autistic children appear to be unconnected with people. But after several years of playing instruments in Cao's symphony orchestra, many autistic children increase and improve their communications with people, which enables them to live more functionally in their ordinary life. Stepping outside of music and with the encouragement of the students with autism and their parents, Cao and his family went on to create more levels of resources. They then started the program of Autistic Café ("A café"), where autistic adolescents learned coffee-making skills from professional coffee-making volunteers for free and ran their café with substantial support from Cao and his family. They also provided free daily classes, called "A Class" by Cao and his family, including subjects of Chinese, Mathematics, and Music for autistic children. Many autistic children transferred to "A Class" because they could not fit into normal or special schools. With their consistent efforts, some of these students did well in entrance exams to college and were admitted to universities as normal high school students. These results had never been imagined by them and their family in the past. Besides, many of them became more independent in their lives, which significantly relieved their family's pressure. Now, Cao and his family launched a new charity foundation in 2021 to respond to the parents' concerns for those Autistic children and adults' future. The foundation will enable the operation of a lifelong program for Autistic children, aimed to help them fit into society and live high-quality lives. Because of Cao's outstanding contribution, he was awarded the prize of 2021 National Role Model.

The above several paragraphs captured some of the contributions that Cao and his Family made to students' mental health and Autistic people's lives. Though he is 97 years old, he and his family are continuing their story with students. At the beginning of their work with students, Cao might just intend to spread the beauty of music to students, but his long-term work apparently promoted students' mental health in an untraditional way. His students are more resilient, connected, and devoted in life through music education and practice, and more importantly, through Cao's role modeling. Cao and his family's persistence in helping students and people with special needs are inspiring and impressive.

6 Latest Research

This section reviews the latest research relevant to student mental health published in high-level Chinese academic journals. Papers published by Chinese scholars in English journals with similar topics will also be discussed. This section provides an analysis on relevant research publications in mental health education in China, to reveal the research focus and interests among Chinese scholars. The purpose of this section is to fill in the gap by providing an analysis of relevant research publications in mental health education in China.

6.1 An Overview of Current Research Focus in Mental Health Education in China

6.1.1 Methods and Sample Features

The purpose of conducting a study on the recently published journal articles is to identify hot topics and central themes among Chinese scholars in the latest research. Therefore, six high-level Chinese journals whose publication scope is partially or entirely on student well-being and school mental health are selected, that is, *Acta*

Psychological Sinica (*Xinli Xuebao*), *Advances in Psychological Science* (*Xinli Kexue Jinzhan*), *Psychological Science* (*Xinli Kexue*), *Chinese Journal of Clinical Psychology* (*Zhongguo Linchuang Xinlixue Zazhi*), *Psychological Development and Education* (*Xinli Fazhan yu Jiaoyu*), and *Chinese Mental Health Journal* (*Zhongguo Xinli Weisheng Zazhi*).

A total of 351 articles on the well-being or mental health of students, teachers, school-age children, and adolescents are found and selected from these six journals (the last issue of 2020 and all issues of 2021). The literature analysis in this section is based on these articles and keywords, which includes 1,529 keywords and 351 articles.

Regarding the sample features, the majority of the 351 articles focus on student populations, whereas only 12 articles focus on teachers. Among the articles on student population, 44 articles focus on elementary school students, 154 on middle school students (97 articles on junior-high schoolers, 52 articles on senior-high schoolers, five articles did not specify), 139 articles on college students, and six articles on post-graduate students. Several articles include cross-sectional analysis, covering students from different stages. Additionally, 23 articles focus on socially disadvantaged populations, including left-behind children (eight), migrant children (five), people with poverty (four), people with disability or special diseases (three), and the LGBT population (three).

6.1.2 Keyword Analysis

Many studies focus on one or more typical psychological problems, including depression or depressive symptoms (53 articles), anxiety (38, with 14 specifically on social anxiety), 21 focusing on aggression and externalizing problems (21), loneliness (11), autisms (9), eating disorder or emotional eating (3). There are also articles on bullying behaviors (28), including campus bullying (16) and cyberbullying (12).

For psychological problems related to modern technology, these articles focus on internet addiction (12), and mobile phone addiction or problematic phone use (22). The articles on internet addiction cover various addiction types, including online social media or online social interaction addiction, online gaming addiction, short video addiction, and internet addiction in general. The articles on mobile phone addiction mostly (16 out of 22) focused on college students. This may be due to the fact that college students have less regulation on their phone usage on campus. Additionally, the internet plays a key role in people's daily life, not necessarily a negative factor. There are more than 10 articles studying social media use, online interactions, online reading, and online gaming in a neutral manner, as well as articles conducting online psychological interventions to improve student mental health.

Regarding key interpersonal relationships related to students' well-being and mental health, the family factors seemed to receive the most attention. Reflected from keywords, there are 68 keywords either on parenting (36) or on family factors (32, including family structures, communications, environment, and parents' characteristics). Comparatively, only 32 keywords focus on peers and classmates, and 14 keywords on teachers. This focus on family factors is consistent with Asian values of emphasizing family in one's development (Kim et al., 1999). It should be noticed that teachers' roles are emphasized in the Chinese context as well. However, teachers' supportive behaviors toward students are embedded in teaching behaviors and are currently still mainly captured in educational journals, not in psychology journals.

6.1.3 Comparisons of Research Focus Across Countries

To better identify the features of the latest research done regarding Chinese students' mental health, eight systematic review papers published in the last five years, all the articles published in four high-level psychology journals and three important school psychology journals (see the table for the complete list) are reviewed to identify central themes and hot topics in the world, especially Western countries. These seven journals together are in similar publication scopes as the aforementioned six Chinese journals. It should be noted that school mental health journals in China are mainly written for practical skill sharing (e.g., case reports and counseling technique applications in schools), whereas empirical studies and systematic literature review papers are already covered in the aforementioned seven Chinese journals. However, in Western countries, there are specific school psychology journals that include research on school mental health and student well-being. Therefore, excluding specific school psychology journals to reach a seeming scope match between journals would miss key research, thus, three important school psychology journals are also included (Table 7).

After reviewing these articles in depth, it is evident that the research shares similar major themes. However, articles on the same theme usually cover different

Table 7 Key academic journals in psychology and mental health selected for this section

Journals in Chinse	Journals in English
Acta Psychological Sinica (Xinli Xuebao)	*Psychological Bulletin*
Advances in Psychological Science (Xinli Kexue Jinzhan)	*Psychological Science*
Psychological Science (Xinli Kexue)	
Psychological Development and Education (Xinli Fazhan yu Jiaoyu)	*Developmental Psychology*
Chinese Journal of Clinical Psychology (Zhongguo Linchuang Xinlixue Zazhi)	*Journal of Abnormal Psychology*
Chinese Mental Health Journal (Zhongguo Xinli Weisheng Zazhi)	
	School Psychology Review
	School Psychology
	School Mental Health

Notes The journals arranged in the same row have roughly similar publication scopes

Table 8 Research focus and topics in China and western countries by theme

Themes	China	Western countries
Addictive behaviors	Internet addiction, social media addiction, phone addiction	Substance use, drug addiction
Campus safety	Bully, cyberbully	Bully, gun violence, criminal behaviors, substance use
Special population	Left-behind children, migrant children	Racial and ethnic minority

topics across countries due to societal conditions. A list of central topics and their corresponding themes summarized by the authors were listed in the table below (Table 8).

Similar to scholars from Western countries, scholars in China are also interested in addictive behaviors, campus safety, and social justice issues. However, due to strict law regulations inhibiting using or transaction of addictive drugs, students are seldom involved in substance use and drug addiction. Addictive behaviors among Chinese students mainly take the form of internet addiction. Regarding campus safety, what counts as threatening to students' security and sense of security varies. Cyberbullying started to receive more attention in China as it stands out as a common type of bullying behavior, whereas in Western countries, gun violence, weapon carrying, and substance use seem to be a more obvious threat to campus safety. As for the special population being focused on, each country's focus on social justice is different. China is going through rapid social change and urbanization, and the whole society cares about whether the wealth and benefit distribution is fair between urban and rural, and therefore, left-behind children in rural areas or migrant children coming from rural areas receive more attention, whereas, in the U.S., racial equality is a central focus. To sum up, the latest research in Chinese academia regarding student mental health shares similar themes as other countries but has different "hot" research topics based on the society's situation.

6.2 Latest Research on Internet Addiction

The prevalence of internet addiction among Chinese college students showed an upward trend as the estimated prevalence of internet addiction during 2011–2018 is higher than 2005–2010 (Liu et al., 2021). As indicated by the six high-level Chinese journals, internet addiction has received extensive attention from Chinese academia. To better understand the trend in research and the results achieved by them, the authors conducted an expanded literature search. Core papers[6] on student internet

[6] Core papers in this chapter are defined as papers published in either Science Citation Index (SCI) journals, Chinese Social Sciences Citation Index (CSSCI) journals, or journals belong to "A Guide

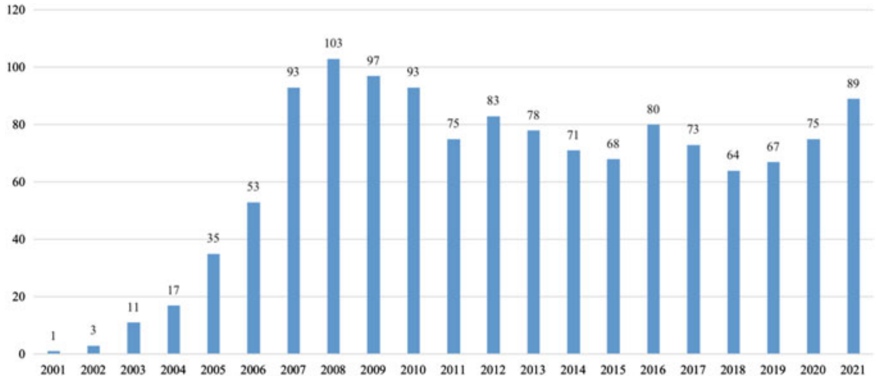

Fig. 1 Number of core papers in each year on students' internet addiction from 2001 to 2021 in CNKI. *Source* Compiled from the count number of papers identified through CNKI search, relevancy check, and duplication removal

addiction are searched from 2001 to 2021 on China National Knowledge Infrastructure (CNKI). A total of 21 key phrases are obtained by pairwise combination: three keywords tapping internet addiction (internet addiction, mobile phone addiction, and social media use), seven keywords tapping students in different education stages (e.g., elementary school students, adolescents, high school students). After removing irrelevant and duplicate records, a total of 1,329 papers from core journals are found on students' internet addiction from 2001 to 2021. The numbers of core paper each year on students' internet addiction from 2001 to 2021 are shown in Fig. 1. As shown in the figure, the number of papers related to students' internet addiction has increased sharply since 2007 and has remained high so far.

Among the 1,329 papers, papers from 2019 to 2021 based on the criteria of being empirical studies or systematic reviews are selected. A total of 204 papers fit the criteria and are sorted into seven categories, as can be seen from Fig. 2, more studies focused on the risk and protective factors of internet addiction.

Regarding the risk factors, alexithymia (Chen & Shao, 2019; Huang & Zhao, 2020; Huang et al., 2021a), loneliness (Huang & Zhao, 2020), self-esteem (Chen & Shao, 2019), social anxiety (Yan et al., 2021), materialistic tendencies (Li, 2021), fear of negative evaluation (Peng et al., 2020), frustration (Dong et al., 2021), stress perception and negative emotions (Zhang et al., 2021a), perceived social exclusion (Xu et al., 2021), perceived stress (Chu et al., 2020), and negative experiences in childhood (Li et al., 2019a; Yue et al., 2020; Zhu et al., 2021) can significantly predict internet addiction. Conversely, mindfulness (Huang & Zhao, 2020), social support (Ling et al., 2021; Zhang et al., 2021a), and family intimacy (Chen & Sun, 2021) can effectively regulate internet addiction. Emotion regulation, self-efficacy (Huang et al., 2021b), self-control, psychological resilience (Huang et al., 2019a),

to the Core Journals of China" (GCJC) from Peking University Library. GCJC is a leading journal evaluation system of academic journals in China.

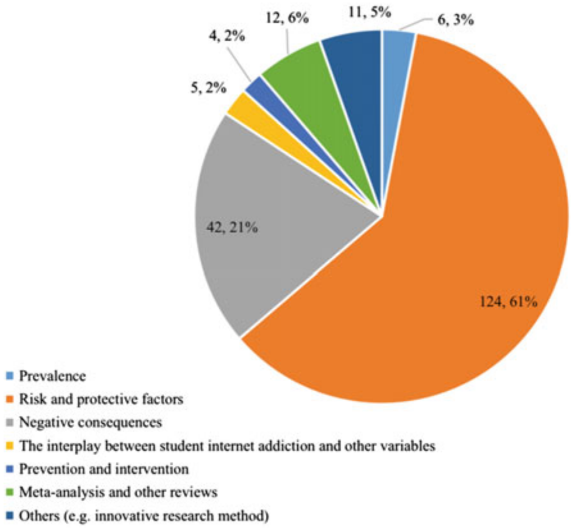

Fig. 2 Number of core papers in each category on students' internet addiction from 2019 to 2021. *Source* Compiled from the count number of each category of empirical studies or systematic review papers identified through CNKI search, relevancy check, duplication removal, and category coding

and clarity of self-concept (Li et al., 2019b) are important protective factors. Family factors are very important in understanding students' internet addiction. Appropriate behavior monitoring, good communication, and warm support from parents (Ma et al., 2021) can significantly improve the symptoms of internet addiction; on the contrary, parental conflict (Deng et al., 2020) and parental neglect (Lin et al., 2021) will worsen the situation. Finally, several studies have found that internet addiction is closely related to sleep (Wang et al., 2021b; Luo & Hu, 2021; Hu et al., 2021), depression (Cui et al., 2021; Hou et al., 2021), and fear of missing out (Zhang et al., 2021b). These comorbidities create vicious cycles that worsen the students' situations.

Many studies focus on the COVID-19 pandemic as an important context in understanding internet addiction. This ongoing pandemic has brought dramatic changes to people's life by largely restricting offline actions and transitioning academic work online. Jiang et al. (2021) show that the internet addiction situation of the first 2,700 college students who returned to school during the pandemic is not optimistic, especially those who dislike exercise, are introverted, and whose family economic situation is damaged. Some scholars pointed out that boredom tendency (An & Ding, 2021) and learning burnout (Wan et al., 2021) can significantly predict internet addiction. Moreover, under COVID-19, college students' internet addiction is accompanied by poor lifestyles, such as sleeping late and getting up late, being sedentary, not exercising, gaining weight, and having negative emotions (Huang et al., 2021c).

From 2019 to 2022, the research on the prevention and treatment of students' internet addiction mainly focused on group cognitive therapy and exercise (Lu et al., 2021; Wen & Chen, 2020). According to a meta-analysis, there are many effective interventions, including cognitive behavior therapy, general psychological intervention, group counseling, and exercise intervention (Wu et al., 2019). In addition to group counseling and exercise, individualized social norm feedback can also promote adolescents to form a more accurate understanding of the common internet-using norms, so as to effectively reduce their internet time and internet addiction tendency (Huang et al., 2019b).

6.3 Latest Research on School Bullying Behaviors

To better understand the trend in research on school bullying behaviors and the results achieved by them, an expanded literature search is conducted. Core papers on bullying published between 2001 and 2021 are searched on CNKI. The keywords "school bullying", "peer bullying", "peer rejection", "cyberbullying adolescents", "peer aggression", "school violence", and "school bullying" are searched with connection by "or". After removing irrelevant and duplicate records, a total of 859 papers from core journals are found on school bullying. Figure 3 shows the number of articles in each year. Following that, the exclusion criteria (non-academic, irrelevant articles, studies on school bullying in other countries) are applied to 859 papers in order to extract empirical studies and systematic review articles, and a total of 255 empirical articles and 18 review and meta-analysis articles are selected. Among these 255 empirical articles and 18 reviews, 134 articles are published from 2019–2021. Figure 4 shows the research types of the 134 articles.

As can be seen from Fig. 3, the research on bullying behaviors has increased largely since 2017. Similar to internet addiction, more studies focus on risk and protective factors. Additionally, by reviewing the paper titles, since 2015, scholars have started to target specific populations to form a better understanding of bullying

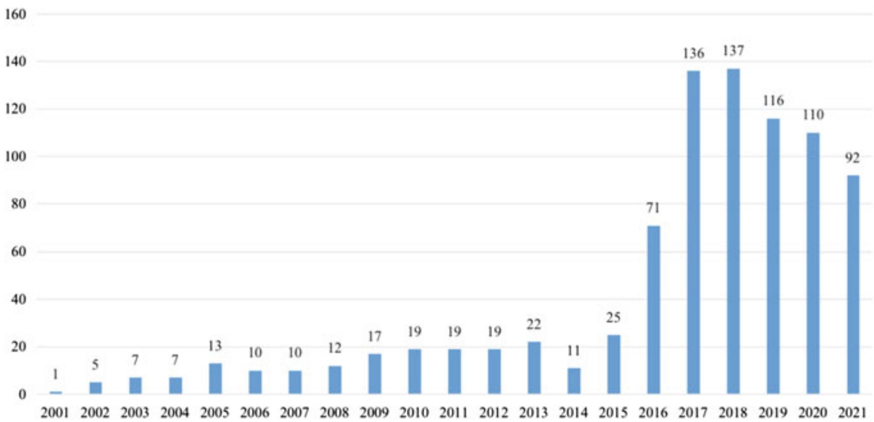

Fig. 3 Number of core papers in each year on school bullying behaviors from 2001 to 2021. *Source* Compiled from the count number of papers identified through search results from CNKI search, relevancy check, and duplication removal

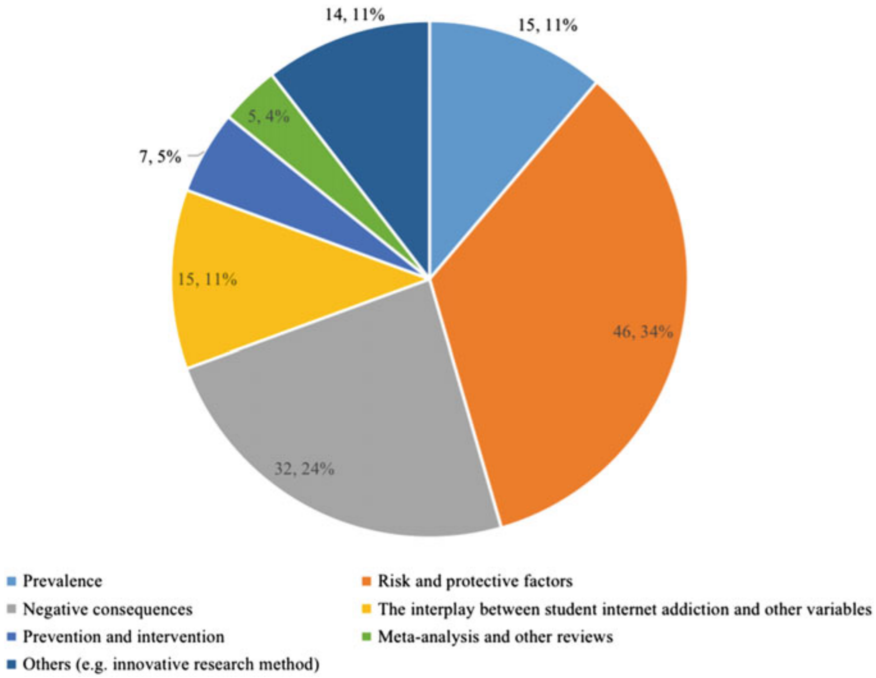

Fig. 4 Number of core papers in each category on school bullying behaviors from 2019 to 2021. *Source* Compiled from the count number of each category of empirical studies or systematic review papers identified through CNKI search, relevancy check, duplication removal, and category coding

according to student subgroups, including sexual minority students, rural boarding students, disabled students, left-behind children, etc.

The studies find that gender, previous violence, condition of romantic partners, and family type are factors influencing violence victimization among college students (Liao et al., 2020). Peers influence aggressive behaviors, and adolescents select friends based on similarities in physical aggression and are influenced by friends to engage in aggressive and bullying behaviors. This effect is more pronounced in middle school (Sun et al., 2019). Peer aggression is significantly and positively associated with aggressive behavior in children and adolescents (Chen et al., 2022b). Boys in elementary schools, middle schools, and high schools with poor academic performance, high academic stress, and negative behavioral habits are more likely to bully others or be bullied, and poor family economic conditions are also a risk factor for being bullied. Low level of parental education is a protective factor against bullying others and low mother's education level is a protective factor against bullying (Zhang & Gu, 2022).

There are also several studies focusing on how to intervene or prevent school bullying. In terms of specific interventions, one study implemented health education, life skills education, and behavioral reinforcement interventions for students in the intervention group, demonstrating the effectiveness of the above interventions in reducing school violence (Zhang et al., 2015). Another study, adopting an experimental design to investigate the effects of interventions on mental resiliency group counseling, finds that the intervention group of elementary school students have significantly higher levels of mental resilience, and lower levels of state anxiety and bullying (Sang et al., 2019). By examining case studies of social work service projects, the feasibility and effectiveness of bullying prevention under social work services are also demonstrated (Yang, 2020).

6.4 Latest Research on Resilience and Psychological Quality

Among the 351 articles from the six Chinese top-tier journals, some articles focus on positive individual characteristics as protective factors. The most studied concepts are resilience and psychological quality (*xinli suzhi*). Psychological quality is a concept regarding positive personal characteristics developed by Chinese scholars that are widely used in educational settings and beyond. This concept is introduced in the late 1980s to go hand in hand with a national policy promoting well-rounded education (Zhang, et al., 2017). To some extent, this concept has been used interchangeably with resilience in daily language and by some Chinese scholars. Both resilience and psychological quality emphasize personal characteristics that can promote one's positive adaptation facing stress and adversity (Wagnild, 2003; Yu & Zhang, 2007). Since a person with strong psychological quality can internalize external stimuli into stable, derivative, and developmental functions in a creative manner and thus be more adaptive (Zhang & Wang, 2012), Chinese scholars argue that psychological quality is a broader concept than resilience (Zhang, 2003).

Accordingly, there are slight differences in the measurement of the two concepts. Yu and Zhang (2007) measure resilience by adopting the Connor-Davidson Resilience Scale (CD-RISC), which includes three sub-dimensions: tenacity, strength, and focusing on the positive; Hu and Gan (2008) measure resilience in five dimensions: goal focusing, emotional controlling, positive cognition, family support, and interpersonal assistance. As for psychological quality, most scholars in China use the measure developed by Zhang and his colleagues, which includes three sub-dimensions: cognitive quality, personality quality, and adaptation (Hu & Zhang, 2015; Hu et al., 2017; Wu et al., 2017).

Despite these differences, the studies on resilience and psychological quality are similar and complementary to each other. Some scholars even use the terms interchangeably. Over the last 30 years, Chinese researchers have conducted research on resilience or psychological quality among students in all the academic stages and connected it with various student outcomes including mental health, academic achievement, and social adjustment. Research participants tend to be more diversified in the late years and groups with experiences or relative vulnerability received more research attention, such as students with disabilities (Jiang et al., 2022), ethnic minority students (Liao et al., 2019; Zhao et al., 2019), left-behind children (Du &

Zhang, 2021; Luo & Zhou, 2017; Miao et al., 2021), and students who have experienced peer victimization (Wang et al., 2017). Another trend is that more and more researchers have published huge amounts of articles in academic journals in English using the term "psychological suzhi", which indicates scholars' interest in this endogenous concept developed by Chinese scholars.

Generally, resilience and psychological quality serve as independent variables or mediators in quantitative research. For example, resilience can significantly and positively predict the social adjustment of ethnic minority students at pre-college preparatory programs in the Han district (Liao et al., 2019); there is a significant positive correlation between students' perceived school climate and subjective academic achievement, and psychological quality plays a significant mediating role between perceived school climate and subjective and objective academic achievement (Nie et al., 2018); psychological quality partially mediates the relationship between teachers' emotional support and academic achievement (Chen et al., 2018). In addition, there are also empirical studies exploring the factors affecting resilience, for example, Du and Zhang (2021) find that the school type, peer environment, teacher-student relationship, and peer relationship can all have a significant positive impact on the resilience of left-behind children. Liang and his colleagues (2017) explore the development of psychological quality among elementary school students in Grades 3–6 from a developmental perspective.

Many studies focusing on resilience and psychological quality go beyond the educational setting. Factors like family environment and parenting play significant roles in students' development by affecting resilience as a pathway which is eventually reflected in their adjustment outcomes. For example, Cheng et al. (2018) find that psychological quality mediates the relationships between middle school students' family socioeconomic status and academic achievement. Li (2018) find that parenting style influences high school students' academic engagement through the mediating role of resilience. Cheng et al. (2019) find that psychological quality partially mediates between parental involvement and problem behaviors. In addition, researchers in recent years have found that many factors in the family predict resilience and psychological quality. For example, paternal and maternal attachment avoidance negatively predicts the psychological quality of middle school girls through paternal and maternal-child attachment (Pan et al., 2021). Liang et al. (2018) find that family function can predict psychological quality of students in upper elementary schools. In short, the research on resilience and psychological quality together helps identify risk and protective factors, and effective interventions for student mental health problems.

7 National Policies

7.1 Fundamental Policies

The national policies regarding student mental health have gone through three stages: preparation (1978–1999), beginning (2000–2010), and development (2010–present) (Yu & Ju, 2018). In the stage of preparation, support for student mental health was defined as providing mental health education for students. Mental health education has been considered an important aspect of moral education for a long time. In the *Regulations on Moral Education in Elementary and secondary schools (Abolished),* issued in 1998, moral education was emphasized, leading to the assurance of students' healthy development and schoolwork and the cultivation of students' political, ideological, ethical, and psychological qualities (MOE, 1998). The policies administered by NHC put greater emphasis on health education and intervention. *Mental Health Law of the People's Republic of China* (National People's Congress, 2012) regulates the roles of schools and teachers in recognizing and assisting student mental health. Therefore, schools, as the responsible party, are required by MOE to take care of students' psychological growth through psychological activities and daily education.

With the reform of national policies regarding students' mental health in the last three decades, the essential conceptualization of students' mental health experienced changes. At the beginning and growing stages, support for student mental health has been still defined as rooted in education and guidance. Psychological services have been gradually considered as an added form to deliver student mental health support. Support for student mental health is not limited to mental health education at schools, but also be delivered via psychological counseling, consultation, and intervention.

Going through three stages, Chinese national policies regarding student mental health become more systematic, specific, and diverse. In the earlier years, several governmental departments separately issued policies regarding student or child mental health. In recent years, they have issued joint policies about student mental health policies (Yu & Ju, 2018), which increases the efficiency of the system of promoting student mental health. For example, in 2008, 17 ministerial-level units including the Ministry of Health (MOH) and MOE jointly issued the *Guiding Outline for the Development of the National Mental Health Work System (2008–2015)* (MOH et al., 2008), which emphasizes that the school should focus on the implementation of quality education, integrate the student mental health education and prevention of mental and behavioral problems among students into school daily work plan (Li & Gao, 2013). In the next sub-section, more information about recent leading policies will be introduced.

7.2 Recent Policy Highlights

In recent years, MOE and NHC have issued new policies regarding student mental health, which further expands and clarifies methods of student mental health promotion. Compared to previous policies, the updated policies make more concrete and multi-level requirements in their text, which indicates a more comprehensive governmental perspective and approach. Specifically, four measures are articulated in the updated policy of *Notice on Enhancing the Management of Students' Mental Health* (MOE, 2021b) to increase the effectiveness of student mental health support, which are "strengthen source management to fully enhance students' mental health literacy", "strengthen process management to improve levels of early detection and counseling and consultation", "strengthen result management to enhance crisis intervention abilities", and "strengthen support management to enlarge comprehensive support levels."

7.2.1 Strengthening Source Management to Fully Enhance Students' Mental Health Literacy

The goal of source management is to promote students' mental health knowledge, awareness, and coping skills by cultivating their mental health literacy and actively providing specific guidance as needed. To achieve this goal, elementary schools, secondary schools, and HEIs are required to set up required courses of mental health literacy and other forms of mental health education activities, including selective courses and social practices. Schools are also required to integrate mental health education into physical, aesthetic, and labor education to cultivate students' positive psychological traits. Additionally, teachers are to be updated regarding students' mental health status through daily communications and school-family-community partnerships. Students who experience stressful events should be paid extra attention and provided guidance as needed (*ibid*).

7.2.2 Strengthening Process Management to Improve Levels of Early Detection and Counseling and Consultation

This element requires county-level education departments to administer assessments of students' mental health status and track every student's status annually, in collaboration with professional agencies. As required, the county-level education departments should also guide schools to understand and make use of students' psychological assessment results, and create a psychological growth profile for every student. The second focus of process management is to develop networks of early warning and intervention. In HEIs, college class advisors and class teachers collaborate with student leaders to observe if any students experience significant frustration or display abnormalities in daily life. In elementary and secondary schools, teachers should take care of students through daily communications and school-family partnerships. Third, they suggest HEIs to further build the platform of counseling and psychological services, and open 24/7 mental health support hotlines. The county-level education departments are required to build counseling centers and provide online and in-person counseling for elementary and secondary school students in their local areas and provide training for local schools (*ibid*).

7.2.3 Strengthening Result Management to Enhance Crisis Intervention Abilities

The crisis intervention and management system is advised to build upon family-school-community partnerships. Regarding family-school partnerships, school is suggested to develop intervention and crisis plans with on-campus and off-campus professionals, and administer the plan together with parents. The mental health medical institutes should provide support for elementary and secondary schools and HEIs regarding crisis intervention system building and medical requests. The policy also gives guidelines to schools and HEIs about how to respond to social comments (*ibid*).

7.2.4 Strengthening Support Management to Enlarge Comprehensive Support Levels

The policy regulates the number, qualifications, and continued training of psychological teachers and professionals in elementary and secondary schools, HEIs, and county-level teaching and research institutes. As described, every HEI should have at least two full-time mental health education teachers, and the ratio of mental health educators to students must be no less than 1: 4,000. College class advisors in HEIs are encouraged to study psychology as their second master's degree and are required to receive training in psychology to develop their psychological and counseling skills. Every elementary and secondary school is required to have at least one full-time mental health education teacher. Elementary and secondary school teachers should take training about psychology and mental health as their priorities. More importantly, this section clearly states that county-level education departments, HEIs and elementary and secondary schools should offer space and financial support for counseling and mental health education (*ibid*).

In sum, the *Notice on Enhancing the Management of Students' Mental Health* is currently the leading policy guiding educational institutions in China to support students' mental health and promote their psychological well-being. The *Notice* has several significant changes, compared to former policies. First, the school-family-community partnerships are repeatedly emphasized. Whichever students' psychological cultivation, recognition of warning signs, early intervention, and crisis intervention, school, family, and community are advised to work together to help students in all directions. The second significant change is about assessment and active guidance.

The long-term track of students' mental health well-being and the construction of the network for crisis detection and intervention are firstly officially required. Finally, the required number, qualifications, training, space, and financial support for psychological professionals working in educational institutes are specifically required, which guarantees the implementation of this policy.

The other current leading policy on students' mental health is *Health Action in China: Mental Health Action Plan for Children and Adolescents (2019–2022)* (hereafter *the Action*) issued by NHC and other 11 central agencies in December 2019. In the past, NHC co-developed *Mental Health Law* in 2012 and *Guidelines on Enhancing Mental Health Services* in 2016 for the general population (National Health and Family Planning Commission,[7] et al., 2016). In 2012, NHC issued *Guidelines for Student Mental Health Education* (MOH, 2012), which specified the goals, principles, and methods of student mental health education. *The Action* for children and adolescents is the most recent policy that NHC directly developed for students. Policies in *the Action* are developed from the policy of *Health Action in China (2019–2030)* (NHC, 2019). The goal of *the Action* is to enhance the health and psychological well-being of children and adolescents by creating a positive social environment for children and adolescents' mental health, building school-community-family-media-medical institutes partnerships for mental health services, implementing intervention measures for children and adolescents' psychological behavioral problems and interventions, and providing extra guidance for vulnerable populations (NHC et al., 2019). *The Action* suggests schools build platforms of psychological services and emphasizes that institutes of early education and special education equipped with full-time or part-time mental health education teachers. It regulates that no less than 50% of parent-schools or family education guidance centers should provide mental health education, no less than 60% of second-and above class medical centers should set up outpatient services for children and adolescents, and no less than 30% of children's hospitals should set up psychiatric (psychological) outpatient services. In *the Action*, cities are required to open or connect with mental health hotline services. *The Action* also set a goal that the mental health key knowledge level of children and adolescents should achieve 80% (*ibid*).

The above goals are developed to achieve through six aspects of actions: Mental Health Outreach Action, Mental Health Environment Facilitation Action, Mental Health Promotion Action, Mental Health Care Action, Mental Health Service Abilities Enhancement Plan, and Mental Health Service System Improvement Plan (*ibid*). In terms of Mental Health Outreach Action, media, medical institutes, health departments, and education departments are encouraged to provide physical and mental health education for children and adolescents individually and with collaboration. In the Mental Health Environment Facilitation Action, active detection and intervention are emphasized. It is encouraged to report and intervene if violence, bullying, or abusive behaviors are found. Students' mental health is directly supported through

[7] The current National Health Commission is previously called Ministry of Health, and later National Health and Family Planning Commission.

the Mental Health Promotion Action. This Promotion Action advises schools to facilitate students' effective communications with peers and family members, to guide students to have one hour of exercise every day, and to receive career and life planning education. In the Mental Health Care Plan, additional care should be given to vulnerable populations, such as students before significant entrance exams, students with mental health disabilities, etc. The Mental Health Service Abilities Enhancement Plan focuses on training for teachers, parents, and professionals working for mental health hotlines to improve their working skills. The System Improvement Plan emphasizes the mental health services set up in schools, HEIs, communities, and medical centers (*ibid*).

In *the Action* mentioned above, NHC emphasizes the support for students provided by medical institutes through specific outpatient psychiatric and psychological services for students and partnering schools, communities, medias, and government departments to provide services of mental health literacy and professional consultation. Additionally, mental health hotlines are frequently mentioned in *the Action*, which indicates the essential role of the hotlines in the mental health support measures by NHC. Compared to the policies issued by MOE, policies issued by NHC are concentrated more on holistic health, reflecting its intentions to improve mental health through consistent physical exercises and sleep quality enhancement.

Overall, these two leading policies share some similarities, such as focusing on multiple partnerships, early detection and active intervention, mental health literacy and awareness improvement, minimum requirements on the teacher-student ratio, and continued training for teachers, parents, and professionals. These similarities may reflect the current philosophy under the work that supports students' mental health in China.

7.3 Other National Policies

A few other policies for specific issues and populations have been developed and issued in accordance with the above national policies. For example, in 2008, when some areas in China suffered from the 512 Wenchuan Earthquake, a devastating earthquake measuring 8.0 on the Richter scale, MOE issued a policy to provide psychological consultation and education for elementary and secondary school students in earthquake-stricken areas (MOE, 2008). At approximately the same time in 2008, MOH issued several policies relieving people's suffering from earthquakes, such as the *Notice on the Construction of Mental Health Support Hotline* (MOH, 2008), as the support hotline was one of the main support channels for people suffering from the disaster at that time. For left-behind children in rural areas, NHC issued a series of policies to support their mental health and psychological development, such as setting up counseling services in rural areas (Li & Gao, 2013). Meanwhile, MOE consistently suggests special instructions for rural students' psychological support in their policies (e.g., developing mental health education classes, and providing school counseling services) (Table 9).

Because of the page limit, not all policies are introduced above. Therefore, key national policies regarding students' mental health are grouped and presented in Table 9 for readers' reference.

Table 9 Key national policies on mental health education or promotion

Year	Issued by	Targeted population	Policies
2002	MOE	Students in elementary and secondary schools	*Guiding Outline for Mental Health Education in Elementary and Secondary Schools*
2005	MOE et al	Students in higher education institutes	*Guidelines on Further Strengthening and Improving Mental Health Education for College Students*
2009	MOE	Students in higher education institutes	*Notice on Strengthening Ideological and Political Education in Employment of Students of HEIs*
2012	NHC	All students	*A Guide of Mental Health Education for Students*
2012	MOE	Students in elementary and secondary schools	*Guiding Outline for Mental Health Education in Elementary and Secondary Schools* (revised in 2012)
2014	MOE	Students in elementary and secondary schools	*Notice on Implementing the Plan of Striving for Characteristic Schools in Mental Health Education in Elementary and Secondary Schools*
2014	MOE	Students in vocational schools	*Moral Education Syllabus for Secondary Vocational Schools* (revised in 2014)
2015	MOE	Students in elementary and secondary schools	*Guidelines for the Construction of Psychological Counseling Rooms in Elementary and Secondary schools*
2018	MOE	Students in higher education institutes	*Guiding Outline for Mental Health Education for Students in HEIs*
2019	NHC et al	All students	*Health Action in China: Mental Health Action Plan for Children and Adolescents (2019–2022)*
2020	MOE	Students in high education institutes	*Guidelines of Accelerating the Construction of a System of Ideological and Political Work in Colleges and Universities*
2021	MOE	Students in elementary and secondary schools	*Guide of Integrating Life Safety and Health Education into Elementary and Secondary School Curriculum*
2021	MOE	All students	*Notice on Enhancing the Management of Students' Mental Health*

8 Summary

This chapter introduces student mental health in China from three aspects: quantitively comparing the student mental health status in China and other countries by identifying key data and creating excellence indicators, qualitatively describing practices and inspiring stories to present approaches and actions in the promotion of student mental health, and reviewing national leading policies and latest research trend in China to show the big picture of student mental health.

This chapter first reviews the most prevalent psychological problems among Chinese students by school-stages, and the overall improvement in student mental health promotion practices in the last three decades. In the highlighting data section, comparable data of suicide rates and psychological problems of students in China is searched, summarized, and compared with those of other countries and the global average. It finds that suicide rates in China from 2000 to recent are relatively lower than other countries, and this trend is the same for the depression and anxiety symptoms among children and adolescents during the COVID-19 pandemic. The most recent and comprehensive estimation of psychological problems among Chinese elementary and secondary students is 17.60%. This indicates continuous efforts are still needed to improve student mental health.

To better understand and compare the status quo of China and other representative countries, this chapter designs a series of excellence indicators that provide a snapshot of students' mental health conditions within the three-dimension structure (student mental health, campus safety, and school support for student well-being). The findings show that Chinese students' well-being and campus safety is similar to their counterparts in other countries. Regarding school support, China is among the few countries that issued policies on mandatory mental health curriculum. Yet, in all seven countries, the professional support offered by school psychologists, which is indicated by its ratio with students, is off from the ideal conditions set by professional associations.

The best practices and inspiring stories sections aim to present representative approaches that individuals and organizations are taking to support student mental health in China, which may not be common in other countries. The three best practices highlighted are school-family-hospital partnerships, all teachers engaged in students' mental health development, and mental health hotlines. These practices have been initiated or developed with the guidance of national policies. For example, the first two practices were initiated after the "Three-Holistic Education" policy was announced. All three practices are not traditional mental health interventions, but they benefit student mental health by expanding channels for psychological professionals and educators to better support students, and students have more convenient access to support and guidance. Three outstanding individuals are also selected to be presented in the inspiring stories. It is interesting that none of them are mental health professionals at the beginning, but they have helped students with their love, learning, patience, and creativity. Even though the role of school psychologist became more emphasized in policies only within the last decade, Chinese educators have already started their efforts in student mental health education and intervention in their creative and unique ways much earlier on. Through student feedback in the above three stories, the integration of mental health education and daily school activities is deemed effective for student mental health promotion.

This chapter also reviews Chinese scholars' efforts in better understanding student mental health problems and identifying effective interventions. Based on the review of Chinese scholars' interests, this chapter selects three heated research topics (internet addiction, school bullying, and resilience/psychological quality) for closer examination. The content and trend of the relevant studies published in Chinese journals are summarized, which indicated that Chinese scholars had made good progress in terms of understanding how these mental health issues develop under various interpersonal factors and contexts, as well as identifying effective interventions among Chinese students.

The national polices section reviews fundamental national policies, recent policy development, and other policies regarding student mental health in China. With the number of policies issued increasing and the content becoming more specific (Ma, 2019), the national policies on student mental health in China become more systematic as a whole (Yu & Ju, 2018). It indicates the government and society's emphasis on student mental health and inner growth (Yu & Ju, 2018). Generally, these policies aim at regulating formal mental health education and professional intervention methods (e.g., equipping schools with school psychologists and counseling rooms) as well as setting up new resources to support student mental health (e.g., advocating integrative force of community and the ecological network around students). This pattern may suggest the Chinese government and scholars' advanced understanding of student mental health.

Even though Chinese students' mental health status is still challenging, many trends reflected in practices and policies are encouraging, such as mental health education being formalized as an essential part of the school curriculum, support for student development becoming increasingly comprehensive and integrated, and psychological services provided to students becoming more professional. Outstanding educators and professionals may play a leading role in further promoting relevant policies and practices. These trends together with the continuous research conducted in this field will keep contributing to improving student mental health in an ever-changing society with increasing uncertainties.

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Appendix A

A list of mental health hotlines in China.

Service targeting populations	Telephone	Organization
Adolescents nationally	12,355	Chinese Youth League of China
Women & children nationally	12,388	All-China Women's Federation
Adolescents in Shanghai	021–61,017,581 021–61,017,555	Shanghai Rainbow Adolescents Development Center
Youth in Beijing	010–64,015,039	China Youth Daily
English-speaking people internationally	400–821-1215	Lifeline Shanghai
Residents in Shenzhen	0755–25,629,459	Shenzhen Mental Health Center
Residents in Hangzhou	0571–85,029,595	Mental Health Center of School of Medicine of Zhejiang University
Residents in Shanghai	962,525	Shanghai Mental Health Center
Residents in China and Chinese people overseas	400–967-8920	Central China Normal University
Residents under COVID stress	400–188-8976	Beijing Normal University

Note This table presents some hotlines targeting students and general populations

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Chapter 11
Global Comparison of International Education

Chen Jiexiu, Zhang Xiaoqiao, and Chen Ruoxi

Abstract This chapter focuses on the global comparison of international education. The first part of this chapter provides a working definition of international education for this chapter as well as an overview of international education in China, and then analyzes China's education mobility from a global comparative perspective. Drawing upon statistics generated from government websites, official yearbooks, and academic reports, the results of this chapter demonstrate that China has effectively promoted the development of international education and international research collaboration in the past few decades. It also shows that China has been catching up with top universities in the world, in terms of the overseas campuses, overseas research center, exchange programs, international faculty ratio, international joint publication, international student ratio, student mobility, and international doctorate degrees. In terms of the student and faculty-related indicators, Chinese universities still have much potential to develop considering the percentages of international students and faculty in Chinese universities are still low. The second part of this chapter introduces the development of international education in China from four aspects, including best practices of international education, stories of inspiring international collaborations, latest research in international education, and overview of fundamental and key policies in international education. This chapter suggests that the continuous improvement of relevant policies, the strengthening of regulatory mechanisms, and the gradual deepening of China's international exchanges strategies have jointly promoted the development of international education in China. International education has an increasingly important role to play in developing global workforce and facilitating cultural exchanges between China and the world.

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1 Introduction

1.1 The Scope and Definition of International Education

International education is a widely used but loosely defined term in both policy discourse and academic discussions, which is closely related with internationalization in education. The concept of "international" was first used in political science and government relations before it was formally introduced into the field of education in the 1980s (Knight, 2003). Knight (2003) described internationalization as "the process of integrating an international, intercultural, and global dimension into the goals, teaching/learning, research, and service functions of a university or higher education system" (p. 1). This definition highlights the long-term, ongoing nature of international education that requires continuous effort.

As a trending topic in education, international education is a dynamic and evolving term that has been interpreted distinctly under different academic and ideological frameworks (Altbach, 2002). Friedman (2000) suggests that international education should not just be a direct product of the Second World War or a by-product of the second era of globalization. Internationalization is essentially a transition of capital across national borders under the influence of neoliberalism (Hanieh, 2011). Altbach and Knight (2007) support this view by stating that international education is fundamentally different from domestic education and is more concerned with profitability. Along with a series of neoliberal educational reforms, such as the privatization of education, international education has become a private good rather than a public responsibility that can be traded. Altbach (2015) further demonstrates that the practical application of this concept in education is specifically seen in the context of internationalization, where host countries promote the enrollment of international students for profit, thus providing a primary income to the domestic economy.

However, Knight (2003) argues that the definition of internationalized education should not be limited to neoliberal economic development. The core of internationalized education should be how to shape policy to promote practice and in turn how practice can influence and reflect definitions and policies. At the same time, Knight (2004) objectively acknowledges the complexity and variability of the definition of international education due to different countries, cultures, and education systems. The diversity of appeal factors structures the different educational frameworks, contexts, and practices within the different countries. The fact shows that international education should not exist independently of the individual country. The underlying dynamic relationships at the national and sector level, as well as the institutional level, need to be fully understood and considered in the definition of international education (Knight, 2003).

In the Chinese context, many scholars have been seeking the use and meaning of such concepts in the Chinese context. According to Gu (2011), international education is not westernization, nor is it international convergence. International education refers to the international exchange of personnel, financial support, information (including educational concepts and educational contents), international cooperation of educational institutions, and transnational educational activities. Internationalization of education is the basic feature of modern education. Based on the review of China's major regulations centered on international education, Gu (2011) analyzed how the concept of international education is interpreted and practiced in the Chinese system. It includes promoting institutional collaborations, recruiting global talents, developing government-school relations, promoting student exchange, collaborating with international organizations to grasp trends and dynamics of international education, and introducing related theories and academic works into the Chinese context.

Considering the wide scope and diverse definitions of international education in both policy discourse and academic discussion, this chapter focuses on the development of international education in China in comparison with global trends. The key themes of this chapter include outbound Chinese students studying abroad, incoming international students to China, and China's international collaboration with international counterparts. It then analyzes the general data, excellence indicators, best practices, inspiring stories, latest research, and governmental policies around this topic. The emphasis of this chapter is on higher education and the scope might expand to other educational levels in future editions of this book.

1.2 The Institutional Development of International Education in China

"International collaborative program" (*zhongwai hezuo banxue*, a term often used in the Chinese context) has a history of more than 140 years from the late Qing Dynasty to the present, and has gone through four main stages, namely, the budding development stage (late Qing Dynasty-Republican period), the exploration and development stage (1949–1977), the recovery and development stage (1978–2000), and the accelerating development stage (2001-present) (Tan & Liu, 2019). Specifically, along with the reform and opening-up, the Chinese government and the United Nations Development Program have signed four projects of strengthening student development and scientific research in key universities. After the reform and opening-up, it is the first group of international collaborative programs between the Chinese government and international organizations. In 1985, Tianjin University of Finance and Economics and the University of Oklahoma in the United States (U.S.) cooperated in organizing a Chinese MBA training course, which became the very first international collaborative program between Chinese and foreign universities since the 1980s. After the 1990s, China gradually strengthened the laws and regulations on international collaborative programs and promulgated a series of rules to regulate these programs. The list included 10 international collaborative programs at undergraduate or higher levels, including the master's program of Change Management jointly organized by Fudan University and the Norwegian School of Management. By 2000, the Office of Degrees Committee of the State Council approved a total of 30 international collaborative programs at undergraduate or higher levels and 11 institutions (Tan & Liu, 2019).

In 2001, China joined the WTO, and according to the commitment, China would open up the education service sector conditionally through a step-by-step process. This caused international collaborative programs to enter a period of rapid development. The State Council issued a number of bills to standardize international collaborative programs and strengthen the supervision of school quality and access. Since then, the development of international collaborative programs has focused on improving quality and increasing efficiency.

At present, there are more than 2,000 international collaborative programs and institutions, with around 600,000 currently enrolled students (including 500,000 students of such programs at university level) and more than 1.6 million graduates from these programs. The exponential growth in both programs and students exemplify how international collaborative programs have entered a new stage of development (Zhang, 2018).

Scholars have identified several major challenges in the development of international collaborative programs. For instance, there is significant imbalance in terms of regional development. As for the enrollment scale of international collaborative programs, the eastern region accounts for 55.23%, the central region accounts for 34.14%, while the western region accounts for only 10.63% (Hong et al., 2016). Among institutions with international collaborative programs, 55 out of 1,679 are located in the eastern region, with a total of 71,820 students. At the same time, there are only five institutions in the western region, all of them locate in Sichuan and Chongqing, with about 2,500 students (*ibid*). In addition, although the education authorities have issued many documents to avoid excessive concentration of international collaborative programs in certain majors, the empirical study finds that two-fifths of the master's students enrolled were enrolled in in management studies programs (*ibid*). The same pattern is also shown in undergraduate programs with two-fifths of the undergraduate students enrolled in those joint programs studying computer and information technology majors, which accounts for one-fifth of the overall enrollment in the international collaborative programs (*ibid*).

Since 2010, both the MOE and universities have attached great attention to the quality enhancement of international collaborative programs. At the governmental level, multiple approaches have been launched to improve overall planning and regulation at the macro level, which includes the enhancement of the quality control system and regulatory mechanism of international collaborative programs, as well as the separation of management, administration, and evaluation. Accordingly, the quality construction project has been promoted comprehensively and the cultivation of high-quality international talents has taken steps forward. Students' employment rate and quality have steadily improved, and the credibility and societal recognition of these programs has increased. Moreover, universities promoted reform and development, and explored comprehensive reform of education and academic construction of higher education institutions (HEIs). Universities provided important experiences for the comprehensive deepening of education reform and academic construction of HEIs (Lin, 2016).

2 Highlighting Data

2.1 Global Education Mobility Overview

To depict global education mobility, this chapter integrates statistical data from the *Open Doors Report 2021* (IIE, 2021) and the OECD enrollment of international students by country of origin (OECD, 2021), to including data on vocational education, bachelor's, master's, and doctoral degree programs. Figure 11.1 presents the number of international students studying in the top eight destination countries over the past few years. In general, the number of international students studying in the eight major destination countries has been on a steady rise, with the United Kingdom (U.K.), Australia, Canada, Germany, and Japan all maintaining a steady upward trend and reaching a peak in 2019/2020.

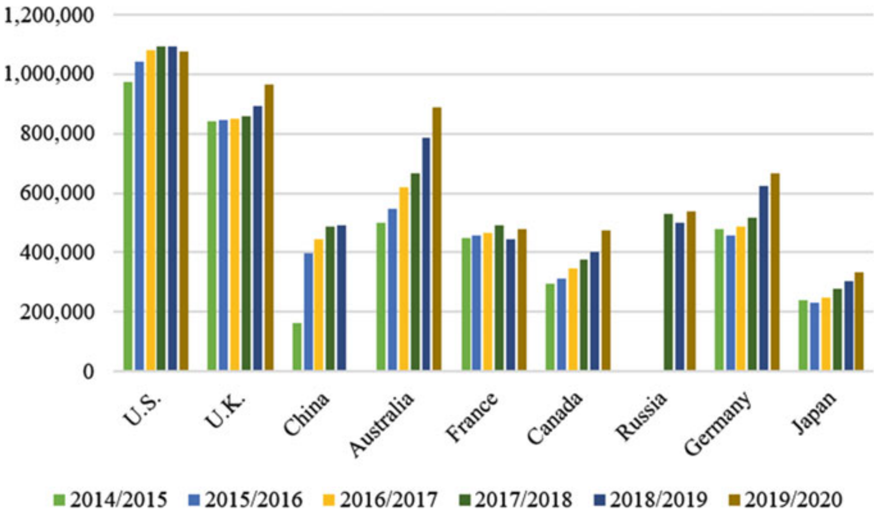


Fig. 1 Number and growth of international students in higher education in the top eight global study destination countries. *Source* IIE (2021); OECD (2021)

Since 2018, the U.K. and the U.S. have hit an inflection point of sustained growth in the number of students studying abroad, with varying degrees of decline in the number of students studying abroad. According to the latest statistics released by IIE in the *Open Doors Report 2021* (IIE, 2021), the number of international students pursuing higher education in the U.S. in the 2019/2020 academic year was 1,075,496, down 1.80% from the 2018/2019 academic year, the first time since the 2008 economic crisis that the number of students studying in the U.S. declined. China continues to maintain its position as the world's third-largest destination for studying abroad. It is worth noting that both France and Russia experienced a significant dive in international students in 2018/2019, but both have since maintained an increase in numbers.

From the perspective of Chinese students, the *2020 Overseas Study Trends Report* (Ipsos, 2020) focuses on the current situation of Chinese students in major English-speaking study destinations (U.K., U.S., Canada, Australia, Singapore), policies and changing trends in study destinations, reputation analysis of overseas universities, and post-study employment insights. For the overseas trend research, the report came up with the following main conclusions. Shares of international students at different stages varies significantly among the five major study-abroad countries. Singapore's 11% share of basic education ranks second in the world according to OECD's, 2018 Program for International Student Assessment (PISA) data (OECD, 2018), and Singapore's bilingual environment makes it easier for younger students to adapt. Australia has a lower basic education share and a more balanced share of undergraduate, master's, and doctoral degrees and above. Canada's 44% undergraduate share, higher than the other four countries, benefits from its low overall study costs, more paid internship opportunities. The U.K. takes a 39% share of master's degree programs, which enroll the largest number of international students in the country. Master's programs at the British universities are attractive due to their short, one-year program length and relatively application process. The U.S. enrolls/attracts 40% of doctoral and post-doctoral students, thanks to its excellent research environment and abundant funding. As such, it is the first choice for doctoral and post-doctoral students interested in academic research.

2.2 Chinese Students Studying Abroad and Returning Home

The *China Statistical Yearbook 2021* (National Bureau of Statistics [NBS], 2021) shows that the number of Chinese students studying abroad and those returning home has been increasing year by year, with a total of 703,500 students going abroad and 580,300 returning home in 2019. The *Annual Report on the Development of Chinese Students Studying Abroad (2020–2021)* (Wang & Miao, 2021) depicts current trends in Chinese international education:

First, Chinese students' study-abroad destinations have become more diversified. Under the combined effect of various factors such as the further opening of international education resources and relatively relaxed and friendly study, Chinese students have more diversified study options for employment and immigration policies of major destination countries. Moreover, more children from ordinary Chinese families have more opportunities to pursue further studies abroad. The number of Chinese students studying in the U.S. may hit an inflection point, and the era of increased diversification of destinations for Chinese students to study abroad is anticipated. According to the *Annual Report on the Development of Chinese Students Studying Abroad (2020–2021)* (*ibid*), although the total number of students studying in the U.S. has continued to increase in the past 15 years, its growth rate has not changed significantly and fell from 29.90% in 2009/2010 to 0.80% in the 2019/2020 academic year. Under the influence of the ongoing pandemic and geopolitical tensions, many Chinese students planning to study abroad are looking to countries and regions with more friendly study environments and visa policies and more effective pandemic control. The statistics in the *Current Situation of Studying Abroad under the New Normal* (EIC Education, 2020) reveal that the proportion of international students choosing to go to Japan, Singapore and New Zealand all showed a slight increase, with the percentages of 4.54%, 3.84% and 2.51% respectively.

In addition, self-funded students are still the largest group of Chinese students studying abroad. According to the report, financial support from parents, relatives, and friends is still the most important source of study abroad funding for Chinese undergraduates. Additionally, the proportion of students relying on this source of funding has increased from 89% in the class of 2013 to 94.20% in the class of 2018. On the other hand, the proportion of students who rely on scholarships and financial support from foreign universities or institutions is decreasing year by year.

Second, international collaborative programs at Chinese HEIs have become a new alternative to study abroad during the pandemic. The international collaborative programs have played an important role during the pandemic, and study abroad in China will probably usher in new development opportunities. According to the report (Wang & Miao, 2021), thanks to the rapid development of international collaborative programs in China, there are new options for studying abroad during the pandemic, and local study in international collaborative programs is becoming a newly available alternative. During the pandemic, international cooperative educational entities are becoming important carriers for Chinese students to carry out online and in-person study in overseas cooperative educational institutions. For example, 3,000 Chinese students from New York University can pursue their studies at New York University in Shanghai (NYUS).

Third, the enthusiasm of students returning to their hometowns continues to rise, and new first-tier cities are more attractive. The number of international students returning to China continues to increase. Having an international perspective has become the new core advantage of the returnee group. As returnees continues to expand, challenges for returnees seeking employment is further highlighted. The group of returnees grew from 130,000 in 2000 to 4,231,700 in 2019, an increase of more than 31 times. Regarding the development advantages of returnees, the 2019 data show that having an international perspective replaces strong language communication skills as the main advantage for their development in China. According to the findings of the *2019 China Returnee Employment and Entrepreneurship Survey*

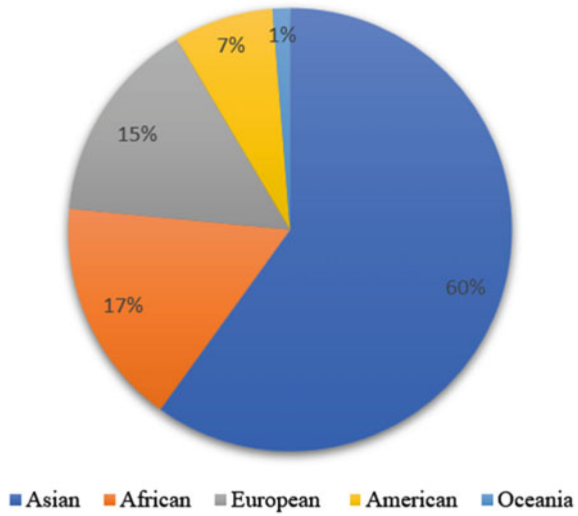
Report (CCG, 2019), the three most important factors that returnees interviewed considered when choosing a city to return to China were: fast economic development, high degree of internationalization, and multicultural inclusion. The returnees recognize the achievements of Chinese enterprises in globalization and are enthusiastic about entrepreneurship. The surveyed returnees were reported to recognize the global development of China's leading local enterprises. Among them, market coverage is generally recognized, but technological influence, global influence, and job-seeking influence fell behind. This indicates that the returnees recognize China's leading local companies well, but there is still room for improvement in enhancing the overall talent attraction.

2.3 International Students Coming to China

According to statistics (MOE), 492,185 international students of various types from 196 countries and regions studied at 1,004 institutions of higher education across 31 provinces (autonomous regions and municipalities) in 2018, an increase of 3,013 students or 0.62% compared with 2017 (Fig. 2).

International Students by Continent. The total number of Asian students is 295,043, accounting for 59.95%; the total number of African students is 81,562, accounting for 16.57%; the total number of European students is 73,618, accounting for 14.96%; the total number of American students is 35,733, accounting for 7.26%; the total number of Oceania students is 6,229, accounting for 1.27%.

Fig. 2 International students by continent. *Source* MOE (2019)



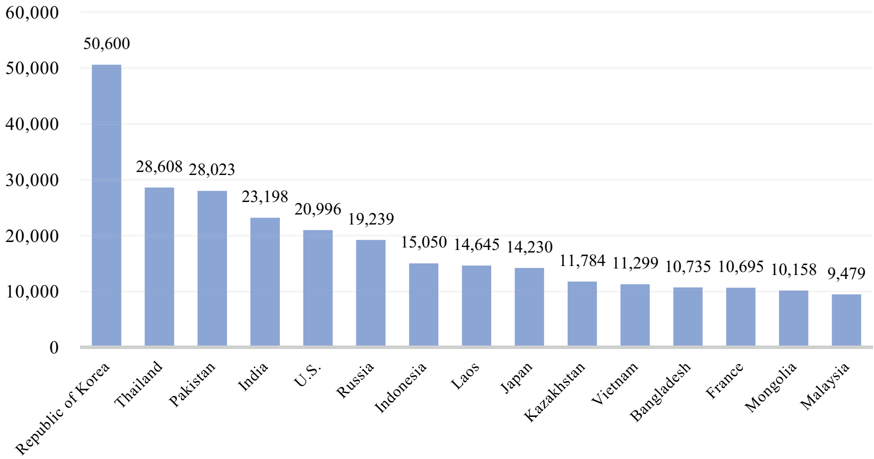


Fig. 3 Top 15 countries of origin of international students. *Source* MOE (2019)

Top 15 Countries of Origin. From Fig. 3, it can be seen that U.S., Japan and France, usually as popular study-abroad destinations for Chinese students, rank 5th, 9th, and 13th among the top 15 countries of origin, which indicates the development of a more dynamic mobility pattern between China and these countries. Moreover, it is also worth noting that some of the countries have participated the Belt and Road Initiative, including the top country of origin of international students, the Republic of Korea (ROK), Thailand, Pakistan, Russia, Indonesia, Laos, Kazakhstan, Vietnam, Bangladesh, Mongolia, Malaysia (Nedopil, 2020), which, to a certain extent, demonstrates the influence of the Belt and Road Initiative in China's neighboring countries.

Top 15 Provinces/Cities Receiving International Students. From the data presented in Fig. 4, the most popular destinations for international students are Beijing and Shanghai, followed by other 8 provinces (Jiangsu, Zhejiang, Liaoning, Tianjin, Guangdong, Shandong, Heilongjiang, Fujian) from East China. Based on the geographical locations of these top 15 provinces/cities receiving international students, a regional disparity exists, with only five provinces from West and Middle China (Shaanxi, Sichuan, Guangxi, Yunnan, Hubei). It is worth noting that, benefited from the Belt and Road Initiative, Yunnan, Guangxi, Heilongjiang and other provinces located along China's national border line have received considerable number of international students in the recent years. According to Gong (2020), the Belt and Road Initiative has reversed the geopolitical disadvantage of the border provinces into a geopolitical advantage, facilitating the development of international education in such areas.

International Students by Categories. The total number of international students receiving academic education programs is 258,122, accounted for 52.44% of the total number of incoming students, an increase of 16,579 or 6.86% over 2017; the

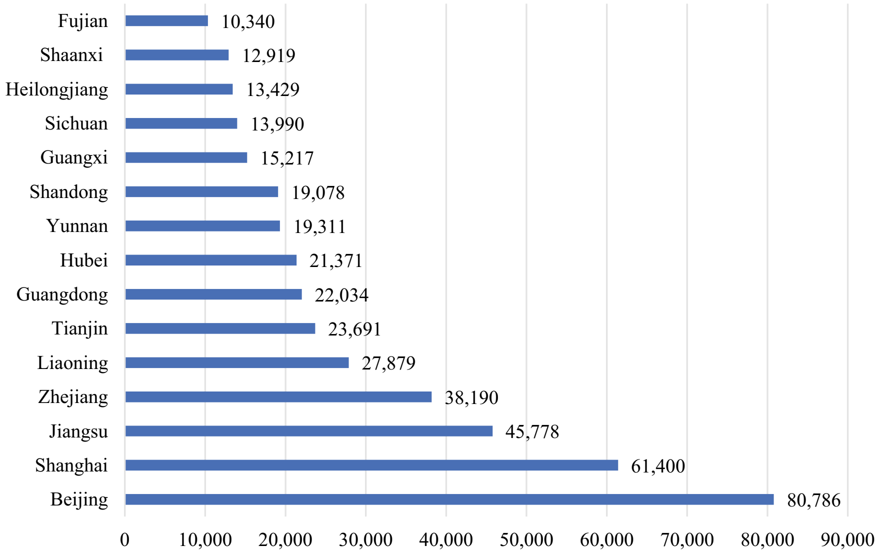


Fig. 4 Top 15 provinces/cities receiving international students. *Source* MOE (2019)

total number of master's and doctoral students is 85,062, an increase of 12.28% over 2017, of which 25,618 are doctoral students, and 59,444 are master's students. In 2018, there were 234,063 international students enrolled in non-degree education programs. (MOE, 2019) (Fig. 5).

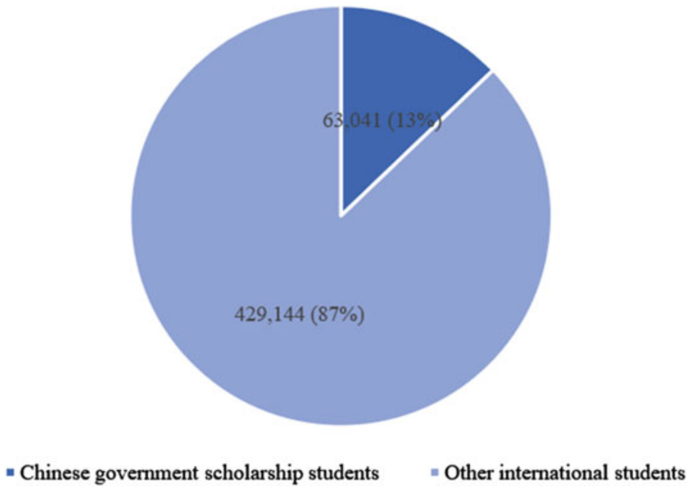


Fig. 5 Funding methods of international students. *Source* MOE (2019)

Funding Resources for International Students. International student". Among these international students, 63,041 students were funded by Chinese government scholarships, accounting for 12.81% of the total number of incoming students, while 429,144 other international students (87.19%) were funded through other resources (MOE, 2019).

3 Excellence Indicators

3.1 Design

To present and compare the universities' level of internationalization comprehensively, three dimensions and eight indicators are selected to measure the overall and average score of each university's performance on internationalization. These dimensions and indicators are chosen with references to the methodologies of the world's leading university rankings (i.e., Academic Rankings of World Universities [ARWU], QS World University Rankings [QS], Times Higher Education World University Rankings [THE]). Also, analysis in this chapter consolidates information presented on world top universities' websites related to internationalization and global mobility and compares this information with the ranking methods presented by ARWU, QS, THE. Analysis of the three global ranking methods reveal that overseas campuses, overseas research centers, and exchange programs are not well presented in those leading university rankings, and these three indicators are the original contribution of the excellence indicator presented in this chapter. By carefully reviewing and examining the ranking method presented by ARWU, QS, THE, six indicators are selected and considered as essential in evaluating universities excellence in international education. Thus, this section includes excellent indicators in three dimensions (i.e., institutional, faculty and students) and eight indicators (i.e., overseas campuses, overseas research centers, exchange programs, international faculty ratio, international joint publications, international student ratio, student mobility, and international doctorate degrees).

Considering the nature of academic excellence, 20 universities appearing on all the three major rankings (ARWU, QS, & THE) and ranked in top 1–25 and 75–100 positions are selected as research subjects. On this basis, the diversity of countries is taken into account, by including countries that are less represented in the international academic market, such as Sweden, Finland, Israel, and Belgium.[1] In order to make

[1] Selected universities include Harvard University, Stanford University, University of Cambridge, University of Oxford, University of Pennsylvania, University College London, The University of Toronto, The University of Tokyo, National University of Singapore, Australian National University, Uppsala University, University of Bonn, KU Leuven, National Sun Yat-Sen University, University of Helsinki, Leiden University, and Hebrew University of Jerusalem.

a valid comparison with Chinese universities, this chapter selects the top 25 Chinese universities from mainstream world university rankings.[2]

3.2 *Definitions and Sources*

3.2.1 Overseas Campuses

This indicator looks at the number of the overseas campuses that a university sets up in foreign nations. Based upon the definition provided in the Observatory on Borderless Higher Education (OBHE) and the Cross-Border Education Research Team (C-BERT)'s report (Garrett et al., 2016), Wilkinds and Rumbley (2018) further incorporate several core features, including ownership, bottom line, substantive control, partnership and infrastructure, and provide a refined understanding of overseas campus. This chapter considers Wilkinds and Rumbley (2018)'s updated and revised discussions as the working definition on "overseas campus" (p. 14). The data of this indicator are collected from universities' official websites.

> An international branch campus is an entity that is owned, at least in part, by a specific foreign higher education institution, which has some degree of responsibility for the overall strategy and quality assurance of the branch campus. The branch campus operates under the name of the foreign institution and offers programming and/or credentials that bear the name of the foreign institution. The branch has basic infrastructure, such as a library, an open access computer lab, and dining facilities, and, overall, students at the branch have a similar student experience to students at the home campus.

3.2.2 Overseas Research Centers

This indicator looks at the number of overseas research centers of a university. The overseas research centers are limited to those with academic functions, not those with a focus on student recruitment or university promotion. Data for this indicator are collected from official university websites.

3.2.3 Exchange Program

This indicator looks at the number of exchange programs of a university. Data for this indicator are collected through universities' websites, which includes the number

[2] Selected Chinese universities include Tsinghua University, Peking University, Zhejiang University, Shanghai Jiao Tong University, Nanjing University, Fudan University, University of Science and Technology of China, Huazhong University of Science and Technology, Wuhan University, Xi'an Jiaotong University, Harbin Institute of Technology, Sun Yat-Sen University, Beijing Normal University, Sichuan University, Beijing University of Aeronautics and Astronautics, Tongji University, Southeast University, Renmin University of China, Beijing University of Technology, and Nankai University.

of exchange programs or partnership universities. For the purposes of this study, exchange programs are defined as long-term exchange programs that are semester-based and have a credit exchange. Since summer/private/intern programs are mostly short-term and include many for-profit programs, this section contains data only on the number of exchange programs that are long-term and credit-bearing in nature.

Some universities present exchange/summer/private programs together on the website. Since most of summer/private/intern programs are relatively short and contain for-profit programs, these data are manually excluded from the data collection process. In addition, some schools offer little information on exchange programs, however they provide information on how many universities the schools have established partnerships with. After comparison, it is determined that the two data elements focus on the same type of cooperation and have been used interchangeably.

The data collection process shows that many exchange programs in U.S. schools were established with U.S.-based schools and can not be considered as overseas collaborations, so the data are removed manually. Some other universities do not have a quantitative presentation of overseas collaborations and exchange programs but only used a qualitative text to describe them (e.g., Cambridge University). In this case, exchange program data were collected based on textual descriptions.

3.2.4 International Faculty Ratio

Values for this indicator are generated from the newest QS ranking data. According to QS methodology, this indicator looks at the ratio of international faculty staff to overall staff. If an institution is attracting a sizeable population of international faculty, this has benefits in terms of research and teaching diversity and collaboration. Further, if an institution is attracting a sizeable number of overseas staff, it follows that it is attractive enough to do so. The number of faculty staff who contribute to academic teaching or research or both at a university for a minimum period of at least three months and who are of foreign nationality as a proportion of overall faculty staff. The term “international” is determined by citizenship. For EU countries, this includes all foreign nationals, even nationals of other EU states. In the case of dual citizenship, the deciding criteria should be citizenship obtained through birth or the first passport. Visiting international faculty staff who are of foreign origin but members of a university other than the one under submission are not counted under this category (QS, 2022).

3.2.5 International Joint Publication

Values for this indicator are generated from the 2022 U-Multirank data. According to U-Multirank’s explanation on its approach, this measure looks at the percentage of the department’s research publications that list at least one affiliate author’s address abroad. The rationale for this indicator is that the number of international joint publications reflects the degree to which a university's research is connected to international networks. It includes the data of international joint research publications and research publications (U-Multirank, 2022).

3.2.6 International Student Ratio

Values for this indicator are generated from the 2022 QS ranking data. According to QS methodology, this indicator looks at the ratio of international students to overall students. If an institution is attracting a sizeable population of international students, this has benefits in terms of networking, cultural exchanges, a more diverse learning experience, and alumni diversity. Further, if an institution is attracting a sizeable number of overseas students, it follows that it is attractive enough to do so. The total number of undergraduate and postgraduate students who are foreign nationals and spend at least three months at a university is a proportion of the total number of undergraduate and postgraduate students overall. The term "international" is determined by citizenship. For EU countries, this includes all foreign nationals, even nationals of other EU states. In the case of dual citizenship, the deciding criteria should be citizenship obtained through birth or first passport obtained. Offshore exchange students and distance learning students are excluded from the calculations (QS, 2022).

3.2.7 Student Mobility

Values for this indicator are generated from the 2022 U-Multirank data. According to the U-Multirank methodology, this measure looks at a composite of international incoming exchange students, outgoing exchange students, and students in international joint degree programs. The rationale for this indicator is that having an international student body and offering students the opportunity to do part of their degree abroad signals the university's international orientation. The data are collected through the institutional questionnaires. It includes the data of incoming students, students sent out in international exchange programs, students in joint degree programs, as well as total students enrolled (U-Multirank, 2022).

3.2.8 International Doctorate Degrees

Values for this indicator are generated from the newest U-Multirank data. According to U-Multirank methodology, it looks at the percentage of doctorate degrees awarded to international doctorate candidates. The rationale for this indicator is that the number of doctorate degrees awarded to international candidates reflects the international orientation of an institution. The data are collected through department questionnaires. It includes the number of doctorate degrees awarded to international doctorate candidates as well as the total number of doctorate degrees awarded (U-Multirank, 2022).

3.3 Findings

With regard to the institutional dimension, all three indicators presented in this chapter use original data. The data of overseas campuses, overseas research centers, and exchange programs are collected from individual university's website. For overseas campuses and overseas research centers, the university's score is the absolute number of their campus and institutions. Considering the number of exchange programs at each university varies significantly (several universities located in Europe report more than 500 exchange programs on their websites), 100 is set as the full score. All universities exceeding 100 will be calculated as 100, and the other universities' scores are standardized accordingly. In terms of the faculty and student dimensions, the data for each indicator are generated from either QS or U-Multirank's website. The newest 2022 data collected appears in a standardized format.

In Table 1, data are presented by consolidating university data into country-specific data, and the country scores are converted into a final score by calculating the average of university scores in the same country. The maximum score for each indicator is 100. Unavailable data are reported as N/A and excluded from calculations of the average score. The total score represents the sum of all the individual scores of each indicator, and the total and average score of each country are calculated.

3.4 Discussion

Chinese universities generally have above-average results in international joint publications, especially compared to similarly ranked international schools. This indicates that China has effectively promoted international research collaboration in the past few decades. In addition, Chinese universities perform reasonably well in the two indicators for international exchange programs and overseas research centers, establishing a solid institutional foundation for deepening international exchange in terms of research and student exchange in the future.

In terms of the student and faculty-related indicators, Chinese universities still have potential to increase their overall scores. For example, the ratio of international students and the ratio of international faculty members are two areas in which Chinese universities perform unevenly, with most universities scoring below average. It is worth noting that the number of international students coming to study at Chinese universities has been increasing in recent years with the increased improvements of regulations governing international students and governmental efforts to promote international student scholarship programs. The indicators related to international

Table 1 Excellence indicators of universities' performance on international education

University	Institutional			Faculty		Student			Total score	Average score
	Overseas campus	Overseas research center	Exchange program	International faculty ratio	International joint publication	International student ratio	Student mobility	International doctorate degrees		
Australia	N/A	N/A	100.00	100.00	86.50	98.80	N/A	40.76	426.06	85.21
Belgium	N/A	N/A	16.00	90.30	94.87	41.40	N/A	N/A	242.57	60.64
Canada	N/A	N/A	100.00	98.60	77.33	94.90	N/A	20.47	391.30	78.26
China	16.67	18.67	59.24	21.22	41.04	17.99	N/A	N/A	174.81	29.14
Finland	N/A	N/A	100.00	56.50	92.04	6.20	N/A	24.84	279.57	55.91
France	N/A	N/A	100.00	24.70	85.43	46.50	N/A	N/A	256.63	64.16
Germany	N/A	N/A	41.00	N/A	83.94	N/A	17.65	30.53	173.12	43.28
Israel	N/A	N/A	100.00	51.80	73.14	9.40	N/A	N/A	234.34	58.59
Japan	N/A	100.00	85.00	3.30	N/A	28.50	N/A	N/A	216.80	54.20
Netherland	N/A	N/A	70.00	78.10	85.96	47.30	N/A	N/A	281.36	70.34
Russia	100.00	N/A	100.00	7.30	54.66	87.80	N/A	N/A	349.76	69.95
Singapore	N/A	N/A	100.00	100.00	92.31	70.30	N/A	N/A	362.61	90.65
Sweden	N/A	N/A	100.00	86.30	90.01	60.40	100.00	47.97	484.68	80.78
Switzerland	N/A	N/A	100.00	100.00	96.63	98.20	23.53	86.92	505.27	84.21
U.K	N/A	4.00	63.00	99.67	91.36	98.73	N/A	N/A	356.76	71.35
U.S	N/A	52.00	54.00	97.67	61.67	69.77	N/A	26.17	361.27	60.21

students are expected to increase significantly in the coming years. However, the percentage of international faculty in Chinese universities is still low. In particular, the number of international faculty within Chinese universities has decreased rather than increased in the last two years, as international academic mobility has been more difficult due to the pandemic. At the institutional level, while most Chinese schools have a slight advantage in the number of overseas academic institutions and exchange programs compared to schools at the same level of the rankings, there is still more room for the development of overseas branches of Chinese universities.

4 Best Practices

The internationalization of higher education in modern world history has never failed to fascinate higher education institutions, provincial and national authorities, and international organizations. Considered as "the process of integrating international, intercultural, or global dimensions into the purposes and functions of higher education" (Knight, 1999, 2004), a cascade of universities has been taking conscious efforts towards improving internationalization with programs and activities taking many different shapes and forms. The idea of "internationalization at home" (IAH) is a comprehensive model to let every student have the global competencies needed in the era of globalization, as Beelen and Jones (2015) proposed "purposeful integration of international and intercultural dimensions into the formal and informal curriculum for all students within domestic environments" (Agnew & Kahn, 2014). China, a latecomer to this inexorable international trend, blazed its own trail and successfully moved from periphery to center of the global higher education stage (Li, 2020). As a Chinese proverb goes, *yindi zhiyi*, which means that tailored and innovative strategies and tactics shall be put in place to tackle local challenges. Thus, it is not difficult to understand that China's approaches to internationalizing higher education are laid on the foundation China's own interpretation about internationalization (Yang, 2016), while absorbing foreign elements to advance its higher education goals. This section reviews strategies Chinese HEIs have adopted to realize internationalization at home, including hiring faculty with more international experience, cultivating more global talents, and developing China-foreign cooperation in university operations.

4.1 Internationalization of Faculty and Students in Chinese HEIs

Faculty play a pivotal role in internationalizing HEIs and students are also "at the heart of internationalization" (American Council on Education, 2022). This section focuses on the numerous strategies used to attain the grand goal, together giving an all-round internationalization of faculty and students in Chinese HEIs.

4.1.1 Recruiting Foreign Faculty

At the institutional level, encouraging faculty to engage in the international context is crucial to internationalization (American Council on Education, 2022). The most obvious method of faculty internationalization is to hire foreign faculty, who have different cultural and academic backgrounds and bring new perspectives to both research and teaching in China. This idea was formally proposed in the *Regulations on the Recruitment of Foreign Cultural and Educational Experts and Foreign Faculty in Higher Education Institutions* (National Education Commission, 1991). The document clearly states that it is part of opening-up policy and put forth the principles of recruitment. As such institutions shall recruit foreign experts and faculty based on national and institutional needs, selecting the excellent candidates, using their strengths, and seeking effective results. Within this structure, hiring foreign faculty has become a long-term effort shared by many Chinese HEIs and an important way to learn advanced science, technology, and culture from the outside world.

This document aims at strengthening faculty and discipline building. To do so, the document also provides guidance on classifying foreign faculty recruitment based upon their fields of study. First, foreign faculty in science, engineering, agriculture, and medical professions shall be hired mainly for short-term lectures and cooperative scientific research. Second, experts of language professions should be mainly hired for training teachers and writing teaching materials, except for practical language classes (including listening, reading, writing, etc.) which can be taught to students. Third, foreign faculty in foreign literature, international journalism, international culture, international trade, international law, international political economy, and international relations should teach parts of courses or hold lectures and seminars mainly for Chinese faculty and graduate students. Fourth, experts in philosophy, sociology, law, political science, journalism, history, education, and other disciplines should conduct joint seminars with Chinese faculty. In addition to adapting to disciplinary needs, this document also requires HEIs to build a relatively complete management system for foreign faculty, with institutional leaders in charge of foreign affairs and full-time staff trained in this business. Institutions shall take initiative to respect foreign faculty, encourage their Chinese counterparts and students to make friends with them, and strengthen cooperation. In doing so, foreign faculty can better understand China and Chinese faculty will also better understand the world.

China has achieved remarkable results in this regard. From 2003 to 2020, only for part-time teachers in Chinese HEIs, the number of foreign part-time teachers has grown from 4,576 out of 134,250 all part-time teachers to 17,686 out of 562,252 (MOE, 2003, 2021). Under the guidance of this document, hiring foreign faculty has been conducive to improving the research and teaching at Chinese HEIs and cultivating talents to serve the socialist modernization construction.

4.1.2 Cultivating Domestic Faculty with International Experience

Apart from employing foreign faculty with selective criteria, Chinese HEIs are very supportive of faculty internationalization by cultivating Chinese faculty with internationalization experience (Cristwell II & Zhu, 2015). At present, there are still some faculty at HEIs have excellent education backgrounds and strong research abilities but lack international education experience and cultural immersion in international contexts, which limits their international vision. Thus, it may be more difficult to support research and teaching, especially in those disciplines with high international relevance. In recent years, Chinese HEIs have emphasizing the internationalization of higher education and cultivating domestic faculty with international experience after they step into the threshold of the work world has been an important part of the internationalizing endeavor.

In the globalized era, Chinese HEIs have attached great importance to cultivating domestic faculty with international experience after transforming from students to faculty. To motivate more local faculty participate in international education, China has taken a series of actions as follows: increasing investment in faculty's international exchange and study, establishing cooperation mechanisms with prestigious international HEIs, regularly selecting outstanding teachers to further participate in international study, increasing opportunities to participate in international teaching seminars, and encouraging teachers to publish high-quality papers in international journals or academic institutions. For example, China Scholarship Council (CSC) issued *Selection Methods of Young Excellent Teachers of Higher Education Institutions for Overseas Training Programs* for six consecutive years (2017–2022), aimed at internationalizing local faculties. The document states that outstanding young faculty in HEIs, who have achieved remarkable results teaching, scientific research or management with solid professional abilities should be sent to well-known universities, research institutes, laboratories in developed countries as visiting scholars or postdoctoral researchers (CSC, 2022). This serves as a measure to encourage faculties to go abroad, immerse themselves in a foreign culture and academic environment, so that after coming back to China, they can work with a more globalized perspective and bring students new insights.

4.1.3 Encouraging Overseas Talents to Return

In addition to hiring foreign faculty and cultivating local faculty with international experience after steeping into the job market, encouraging Chinese overseas talents to return has also been a critical measure in the process of internationalization**.** Studying abroad, an important initiative of China's opening-up, especially that of education, has been developing rapidly in the 13th Five-Year Plan period. Recent years have witnessed a boom in the number of Chinese overseas students. The total number of Chinese overseas students was about 1.6 million in 2020, compared with 544,500 in 2016, an increase of 193% (China Youth Daily, 2020). MOE also issued the document *Several Opinions of the Ministry of Education on Further Strengthening the*

Work of Introducing Excellent Overseas Educated Talents (MOE, 2007), supporting institutions in inviting China overseas talents back to work for the home country.

To boost internationalization, the document offers a comprehensive set of measures. First, it clearly defines "outstanding overseas talents" with three different groups: a group of experts specified in the disciplines leading in the international arena; a large number of outstanding academic leaders with solid academic foundation, outstanding innovation abilities and potential; and a large number of young excellent faculty. Combined these three groups form excellent and innovative teams, promote technological innovation and discipline development, and drive the improvement of the overall quality of the faculty and scientific research teams. Second, MOE has compiled a list of outstanding overseas talents, and established the database of outstanding overseas talents according to the actual needs for talents in education, science and technology, industrial and regional development. In addition, education offices of Chinese consulates abroad have strengthened the management and services for overseas students, and provides convenient, fast, accurate and timely information to serve the needs of overseas talents to work back in China. Third, a two-way selection platform for outstanding overseas talents shall be built for the convenience of these people. Meetings between outstanding overseas students and Chinese domestic employers shall be held to encourage and guide outstanding overseas students to return to work in Chinese HEIs within the framework of China's policy on studying abroad in the New Era, which is known as "supporting students studying abroad*;* encouraging them returning to China; give them freedom to return or stay; let them play their parts!" (MOE, 2020a). Fourth, national science and technology, education and talent funding projects shall be fully leveraged. Outstanding overseas students return to work in China shall be prioritized as part of building world-class universities in HEIs implementing Project 211 and Project 985, with special funding to support. Moreover, MOE encourages HEIs take advantage of "Chunhui (literally means sunshine in spring) Program", which "targets those returnees doctoral graduates with outstanding achievements in their respective fields" (MOE, 2009). This program also motivates outstanding overseas students in key fields to use their academic sabbaticals to return to China and engage in research and lectures at HEIs. This action facilitates soft landing through cooperation, so that some of returnees can eventually return to China for long-term work and could contribute to the emerging and frontier disciplines, internationalization of HEIs, and the building of world-class universities**.**

Internationalization of faculty is the bridge to internationalization of students. The more internationalized the faculty, the more diverse the disciplinary backgrounds, therefore the more students will be attracted to the international perspectives the faculty bring. By recruiting foreign faculty, internationalizing local faculty after they start to work and encouraging overseas talents to return and work back in HEIs, China offers comprehensive measures in internationalization. The internationalization of Chinese HEIs is strengthened by improving teaching quality of the school and cultivating talents with global perspectives and international awareness that enhance social and economic development (Tian & Liu, 2018). Chinese HEIs' strategies for internationalization have been most strikingly featured by its vigorous and various engagement with the outer world. “This attitude is not only unprecedented in its modern history, but also differs much from many other developing countries’ interactions with the developed Western world” (Yang, 2016). “Walking on two legs”, or in other words, combining merits of foreign higher education into practices of Chinese HEIs, has been a strong contributor to the high achievement of China’s higher education internationalization development (*ibid*).

4.2 Integrating Chinese and Foreign Elements to Facilitate International Cooperation in Running Schools

Transnational education is regarded as one of the drivers of bettering international higher education landscape (Ma et al., 2019). China has become, during the past several decades, a burgeoning market for transnational education ventures, with branch campus being one of the representatives. Defined as “legally independent entities formed as joint ventures between Chinese universities and international institutions”, these universities have added fresh impetus to further the internationalization of higher education in China (*ibid*). To drive the development of international collaborative programs, *Implementation Measures of the Regulations of the People’s Republic of China on International Collaborative Programs and Institutions* was issued by MOE in 2004 and gives specific regulations in terms of the establishment, organization, and activities of branch campuses (MOE, 2004). International collaborative programs have been emphasized again in another important document, *China Education Modernization 2035*, which seeks to comprehensively improve international exchange and cooperation and enhance the quality of international collaborative programs (MOE, 2020b). As of June 2020, there were 2,282 Chinese-foreign cooperative education institutions and programs, including 1,196 institutions and projects above the undergraduate level (*ibid*). Among those, nine branch campuses have been well-known in China–Xi’an Jiaotong-Liverpool University (XJTLU), University of Nottingham Ningbo China (UNNC), Beijing Normal University-Hong Kong Baptist University United International College (BNU-HKBU), New York University Shanghai (NYUS), Wenzhou-Kean University (WKU), Duke Kunshan University (DKU), Chinese University of Hong Kong, Shenzhen (CUHKS), Guangdong Technion-Israel Institute of Technology (GTIIT) and Shenzhen MSU-BIT University (MSU-BIT) (*ibid*). This section discusses how branch campuses have integrated Chinese and foreign visions and values, modes of education, and management in their development, contributing to the internationalization of China’s higher education.

4.2.1 Integrating Chinese and Foreign Values

The educational philosophy of a university is the guiding principle of the vision and direction of the university's development. The specific goals, missions, institutions, mechanisms, methods and even the motto, song, flag, emblem, and campus layout are the extrapolation of the university's educational philosophy and unconsciously constrained by it (Lan, 2002). The mottos and educational philosophies created by branch campuses, provide a theoretical framework that integrate the values of Chinese and foreign cultures. For example, co-founded by Duke University in the U.S. and Wuhan University in China, DKU's educational philosophy combines the Duke University motto of "Knowledge and Faith" with that of Wuhan University, "*ziqiang, hongyi*, *qiushi*, *chuangxin*" (which means "self-improvement, perseverance, truth-seeking and innovation") and blends into its existing mission: "to serve truth and justice, to serve society and the nation", which mirrors its goal of cultivating well-rounded global citizens with roots in Chinese culture. Likewise, XJTLU's motto in Chinese is "*boxue mingdao*, *duxing renshi*" (which means "be knowledgeable and bring yourself to reason, practice earnestly, and have broad shoulders") while its English version is "light and wings", meaning "light to see" and "wings to fly". The mottos of XJTLU inherits the meaning of "knowledge illuminates the way" from that of the University of Liverpool in the U.K. (the home university) and incorporates the pragmatic spirit of the motto of Xi'an Jiaotong University (the host university). Similarly, the motto of NYUS, "persevere and transcend, make the world your classroom" reflects both Western pursuit of truth and Chinese pursuit of a practical and innovative life. These mottos provide a cross-cultural atmosphere, connecting students globally and grounding them locally (Tang, 2020).

4.2.2 Integrating Chinese and Foreign Modes of Education

Chinese education has always put emphasis on building a solid knowledge foundation, which can be reflected by a wide reputation of excellence in academic performance from Grade 1 in elementary school to Grade 12 in high school. The potential problem, however, is some students will develop a habit of passive learning that they may carry on to their college years. In comparison, western education is more student-centered and individualized, making it easier for students to expand their horizons and explore their interests and strengths. This can become problematic when HEIs copy the Western style in detail. Successful branch campuses choose a different path and do not simply copy from either mode of education, be it Chinese or foreign. Rather, based on Chinese realities, these institutions provide a cross-cultural model of education by combining the Chinese emphasis on knowledge and the foreign emphasis student-centered teaching and learning. For example, XJTLU features the integration of Chinese, British, and North American modes. First, the university ensures students build a solid knowledge base. This shows Chinese characteristics, but XJTLU has changed the approach to learning from passive learning to active and research-oriented learning. Second, XJTLU borrows British quality assurance system and improves upon it. Third, XJTLU absorbs the flexibility of North America higher education and students are allowed to choose their majors as sophomores. Students are educated with both flexibility and a rigorous quality assurance system, and faculty at XJTLU implement new teaching methods so that students learn in a more exploratory, research-oriented way (EOL, 2021). A similar example can be found in the educational model at DKU, where a system of liberal education, professional education and practical courses were adopted, along with student-centered small class teaching in which students having multi-cultural backgrounds and the opportunity to develop discuss freely and cooperate in teamwork while attaching great importance to how well students have grasped the knowledge (Liu & Li, 2015).

4.2.3 Integrating Chinese and Foreign Management

In Chinese universities, the Party Committee has the highest decision-making power. General policies, development direction, and other important decisions of the university are made or determined by the Party Committee. The president and his team are responsible for implementing these decisions under the supervision of the Party Committee. In western universities, the Board of Directors is the highest decision-making body and is responsible for making decisions on major school issues. The president implements the decisions of the Board of Directors and is responsible for the education, teaching, and administration of the school. This is different from the management system adopted in China. Most of the branch campuses use a system of presidential responsibility under the leadership of a Board of Directors, but also has a Party Committee with some government officials involved. For example, the Board of Directors at DKU has a balanced representation of interests, with a mix of not only Chinese and American administrators (roughly a 50/50 representation from China and the U.S.), but also stakeholders with multiple interests (including university administrators and academics, as well as officials and local business representatives) (Tang, 2020).

From integrating Chinese and foreign visions and values, to modes of education and management, branch campuses have carved out a bright road to facilitating international education in China. Their international outlook along with Chinese characteristics have brought assets to students' enjoying educational experiences there and assist them to become full-fledged members of this global community. Also, to the universities, the outlook helps them become an interdependent society of humankind in a fully global ecosystem.

5 Inspiring Stories

5.1 Xiao Xuehua: A Young Leader of Chinese Overseas Students in Education

Among Chinese overseas students, Xiao Xuehua (Felix) has been a new star in impacting international education, especially to the group of Chinese students studying abroad, with his big aspirations for the future and self-dependence as an intrinsic part of realizing his ambitions. Due to Felix and his friends' dedication, the Chinese Overseas Student Conference and Providence Academy, both aiming to serve Chinese overseas students, now ranks among the most influential and nonprofit organizations among Chinese overseas students. In 2019 at the age of 23, Felix, was named to Forbes China 30 Under 30 list and recognized as one of the 2019 Hurun Report 30 × 30 Leading Entrepreneurs (Forbes, 2019). In an interview with Forbes at its Under 30 Summit, Felix said, "each era has a different ideal and thus needs a group of talents who learn the knowledge and pursue a career to serve the ideal. As Mu Ch'ien[3] said, one should not only follow the times, but more importantly, know the times and lead the times." (Sina, 2019).

Felix became independent throughout his education, which laid the foundation of becoming a future leader. Though born as a Beijing native and his grandparents had enough time to take care of him after schooling, he was still sent to a boarding school. At that time, he was only three and his parents did so in the hope that he could learn to be independent. This expectation did not turn to be a disappointment. According to Felix, with quality time spent with his teachers and schoolmates, he gradually developed the ability of independent thinking and learned to take care of himself. His determination and confidence grew as he refined his interests and strengths. He has always been passionate about photography and at the age of 17, he was awarded The United Nations-China National Campus Contest in Photography "Special Prize". Felix's "self-reliant" journey continued as he became immersed in Western culture while studying abroad. He first studied Visual Arts at Fordham University in the U.S. and later studied Adult Learning and Leadership as a graduate student at Columbia University (Sohu, 2019). Like other students studying abroad, independence became an essential identity, preparing him to become a leader.

In addition to being independent, his educational experience helped him find his passion for education and set goals of contributing to it. During his time at Columbia University, he was influenced by Dr. Cheng Yan Davis, the Special Advisor to the President of Teachers College. "Her dedication and hard work, in education has always influenced and changed me in a subtle way." Felix said (*ibid*). With her mentorship, Felix, together with his friends, co-founded Chinese Overseas Student Conference (*zhongguo liuxuesheng luntan*) and Providence Academy (*pusi xueyuan*), serving the need of a growing population of Chinese overseas students and using

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[3] Ch'ien Mu is considered as one of the greatest historians and philosophers of 20th-century China. (https://en.wikipedia.org/wiki/Ch%27ien_Mu).

multimedia to, such as Bilibili, a major Chinese video sharing and streaming platform, to spread their influence. The Chinese Overseas Student Conference aimed to create a platform for Chinese youth to communicate with accomplished entrepreneurs, experts, scholars, and leaders in various fields, to help overseas Chinese students understand industry trends abroad and at home. Through their guidance, students were encouraged to explore the new world pattern, and to encourage more students to return to China to serve the nation.

As the co-founder and chairman, Felix has organized the Chinese Overseas Student Conference annually for the past six years. Past attendees include Shi Yigong, President of Westlake University, representatives from China's 100 top industry leaders, and Chinese overseas students from high-ranking institutions including Harvard University, Cornell University, Columbia University, University of Oxford, Cambridge University. Discussions have centered on education, finance, artificial intelligence (AI) and others, collectively representing 11 areas of leadership. From 2016–2020, over 6,000 live audience members and more than 120,000 online viewers have tuned in to the Conference (*ibid*). To further advance his goal of developing Chinese leaders Felix and his friends established Providence Academy, a platform for Felix and his friends to lead young people and cultivate more leaders. This mobile platform for global youth seeks to train a new generation of young leaders and calling on global youth to participate in the development of China and contribute their knowledge to build a share community of humanity. The academy's motto is "responsibility, sincerity, compassion, and commitment, to share the responsibility of today and change the future of China and the world". The academy brings together the presidents of academic associations, leaders of major overseas universities, and returnee entrepreneurs (Providence Academy, 2022).

5.2 *Cao Wen: A Pilot in China's International Education*

Professor Cao Wen at Beijing Foreign Studies University (BFSU), worked as the Dean of Graduate School of Education at BFSU, and currently serves as the Chief Academic Officer at International Education Group of BFSU International, a pilot program in China's international education landscape. Because of her dedication to international education and her brave deeds in finding better ways to promote China's international education, Cao was awarded the "China Education Industry Outstanding Contributor" in 2017 (Sina, 2017).

When Cao was a student, she was transformed by studying the English language, which led her to pursue a career in international education. At the start of her college years, Cao studied English Language and Literature at BFSU for her bachelor's degree. Then, as a postgraduate, she chose to explore Distance Learning at the University of Manchester, transitioning as a conventional face-to-face teacher to an online teacher. When attending Nottingham University for her Ph.D., Cao brought her eight-year-old son with her to the U.K. There, her son's rapid progress in learning English surprised her and inspired her to shift her research interests from university education to basic education (Liuxue, 2020). Before long, Cao worked as a visiting scholar at Cambridge University. It was this visit that made her shift her focus from English education to international education, and begin to further explore the internationalization of basic education (*ibid*).

As a promoter of international education during her time in BFSU International, Cao became the Chief Academic Officer of BFSU International after the institution was established in 2014, which provides both curricular and extracurricular services while regarding international education as one of the indispensable elements. Following her lead, the in-class service of BFSU International focuses on providing support for schools, including dozens of schools affiliated with BFSU International and existing or newly founded state or independent schools dedicated to bringing foreign language and international education. BFSU International provides instruction in more than 50 foreign languages and focuses on four major service areas, including leadership and management, curriculum and teaching, faculty development, and student development, which lays a strong foundation for adding international elements into schooling. Extracurricular services focus on international literacy education. BFSU has opened 54 campuses in 15 cities, including Beijing and Nanjing, with more than 42,000 students enrolled. These services combine Chinese classics and international learning together and immerse students in an intercultural learning environment. Together with her colleagues, she has made both curricular and extracurricular services more international, and increased the public's knowledge of international education. (*ibid*).

Through practice, Cao has honed her insights and become a pioneer in international education. When asked Cao how to define the word "pilot" in international education, she said a pilot should create a culture, set up new concepts, set standards, build platforms, provide services, and conduct evaluation. Her work at BFSU International exemplifies this definition. In terms of culture, her institution always emphasizes the academic features in their services instead of following the trend. The institution has published several annual reports concerning international education, widely spreading ideas and cultivating a culture of international education among the public. When it comes to evaluation, BFSU International has developed the "International School Quality Assurance Standard System" by conducting comprehensive research on school accreditation and evaluation standards at home and abroad. Collecting a large amount of empirical data on Chinese international schools, the institution has devoted itself to launching an evaluation standard system that reflects the characteristics of international schooling in China (*ibid*).

Cao believes that "internationalization" is a two-way concept that must include Chinese participation. International education is not as simply as introducing overseas courses or studying abroad, but rather it allows children to see things from different perspectives in China and abroad. The goal of international education is to cultivate "Chinese global citizens and international Chinese". "Being Chinese is the core, but internationalization gives us another mission, which is to introduce China to the world and the world to China" Cao added. For example, since 2015, BFSU International has launched a program called Junior Researchers, in which teachers lead Chinese high school students to explore China's intangible cultural heritage through scientific research methods. From designing a topic, searching literature, conducting empirical research, analyzing data, sharing presentations, and finally completing a research report in both English and Chinese, making students thinking and taking actions in how to better tell Chinese stories (*ibid*).

5.3 Cheng Yan Davis: A Bridge-Builder of International Initiatives: Cheng Yan Davis

Cheng Yan Davis, also mentioned in Felix's story (see Sect. 5.1), is one of the founders of Forum for World Education and is Senior Advisor to the Shanghai Pudong Government. She served as Special Advisor to the President of Teachers College (TC) of Columbia University on international advancement. Before coming to TC, Cheng worked at the University of Pennsylvania (Penn), where she was the Vice Dean of Graduate School of Education (GSE) as well as Special Advisor to the President of the University of Pennsylvania on internationalization efforts (FWE, 2022). Before that, she served as the Vice President of Drexel University. Her forty-year career in international education and exchanges has earned her a reputation as a pioneer in international initiatives, be it China-U.S. relations or internationalization around the world. As such a bridge-builder, Cheng has been recognized with several awards for her outstanding accomplishment in international advancement. She received Penn GSE Alumni Pioneers Award the President Award for Excellent Leadership from Drexel University, the 2012 Outstanding Leadership award from Princess Sirindhorn of Thailand, and the 2017 Princess Maha Chakri Award (OECD, 2019).

Cheng is a practitioner of "East meets West" philosophy and a firm bridge-builder of China and U.S. relations. The starting point of her career began with international education. She founded the first international programs office, GSE International, during her work at Penn in 1993. It is the first office among multiple graduate schools at Ivy-league universities. Following her lead, GSE International has gained an international reputation for excellence, and is at the core of facilitating international development and cooperation for both GSE and Penn. In 2006, she created the Pre-College Program for Chinese high school students, the first among Ivy League Universities, which was well received in both countries (*ibid*). In addition to communications among faculty and students, Cheng helped to build several training programs for groups ranging from university administrators to government officials and corporate executives. The Penn-Securities Association of China (Penn-SAC) Program and the Penn-China Mutual Fund CEO Leadership Program, two of which are the first-ever training programs for executives in Chinese securities and mutual fund industries, have trained approximately 200 Chinese executives with the latest theories and practices of the U.S. finance sector (*ibid*). Additionally, Cheng initiated and organized the U.S.-China Future Leaders Program, which strives to develop a close relationship and improve mutual understanding among the rising young leaders of both nations (*ibid*). Cheng was also a Senior Advisor to Shanghai

Pudong government and Senior Observer for the Shanghai International Business Leaders Advisory Council for the past two decades. Being capable of anticipating professional needs and maintaining good connections both at home and abroad, she built many bridges among many educational institutions, corporations, and government agencies between the U.S. and China. For example, when Pudong Institute of Finance was founded and establishing its academic committee, several U.S. and Europe business schools came to join at Yan's invitation, including Harvard Business School, Wharton School, Columbia Business School, and International Institute for Management Development (IMD) of Switzerland (*ibid*).

Cheng' bridge-building did not stop between the U.S. and China. She took footsteps in building multinational exchanges networks. She established education roundtables with France, New Zealand, Thailand, and China, with each of them "dedicated to information exchanges and joint exploration of the key education challenges facing each participating nation" in the twenty-first century (*ibid*). She is also a trailblazer in international education research by initiating "groundbreaking Six-Nation Education Research Program and its successor, the Eight Nations Education Research Project, which bring together national-level researchers and policymakers from key nations in Asia, Europe, and North America to conduct cooperative research on education policy" (*ibid*). The APEC Math and Science Teachers Program was also launched by Yan, together with programs mentioned above build bridges for education practitioners to enjoy more resources and improve their research and teaching abilities. These collaborative programs, together with all the international initiatives Cheng has participated in, has offered a moment for organizations from different countries to reflect on cultural and education differences which might work as a unique add-on to their communities and inspire themselves to learn from others.

6 Latest Research

6.1 General Overview

In the following section, data of Chinese literature research are obtained from CNKI, including CSSCI, EI, and core journals. Collection years are set from 2003 to 2021, and the keywords used are internationalization (*guojihua*), international education (*guoji jiaoyu*), and international collaborative programs (*zhongwai hezuo banxue*). A total of 1,035 articles are obtained. An English article search is also conducted through the Web of Science (WOS) database core by the keyword international education, and the year is set from 2003 to 2021. This search results in 3,442 documents after filtering and removing duplicates.

Figure 6 visualizes the changes in the number of papers published by domestic scholars on education internationalization research in the past two decades. The number of papers published by domestic scholars on the internationalization of education has shown an overall increase since 2003 and peaked in 2011, with a

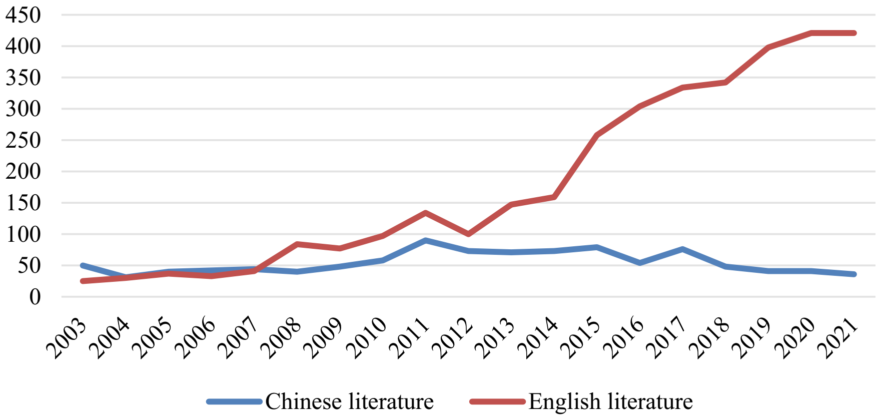

Fig. 6 Trend of the number of Chinese and English publications from 2003 to 2021. *Source* Compiled from search results from CNKI and WOS

decreasing trend through 2021. The second highest point in terms of quantity was ushered in 2015 and 2017 respectively, while the number of papers published on internationalization of education was even lower than 40 in the latest 2021. Since 2007 the gap between the number of English and Chinese research articles on international education have widened. The number of international papers has shown a rapid growth trend. Especially after 2014, the number of documents in international education has been above two hundred and fifty every year.

According to Fig. 7, Beijing Normal University, Xiamen University, and East China Normal University are the main publishing units in the field of education internationalization from 2003 to 2021, including 53 articles published by Beijing Normal University, 44 articles published by Xiamen University, and 24 articles published by East China Normal University. Among them, Beijing Normal University published 53 articles, Xiamen University published 44 articles, and East China Normal University published 24 articles, mainly published by teacher training and national key universities. Among the major English publishers, Monash University, University of Toronto, and Deakin University publish at the highest rates in the internationalization of education field. Figure 7 also shows a large gap in the number of articles published by major domestic and international publishers, but among the top domestic publishers, Beijing Normal University published 53 articles, which is on par with the leading international publisher Monash University (54 articles).

6.2 Research Fo in International Education

As shown in Fig. 8, keyword analysis, word frequency, and extended words were used to identify popular research trends in international education. Through Citespace's

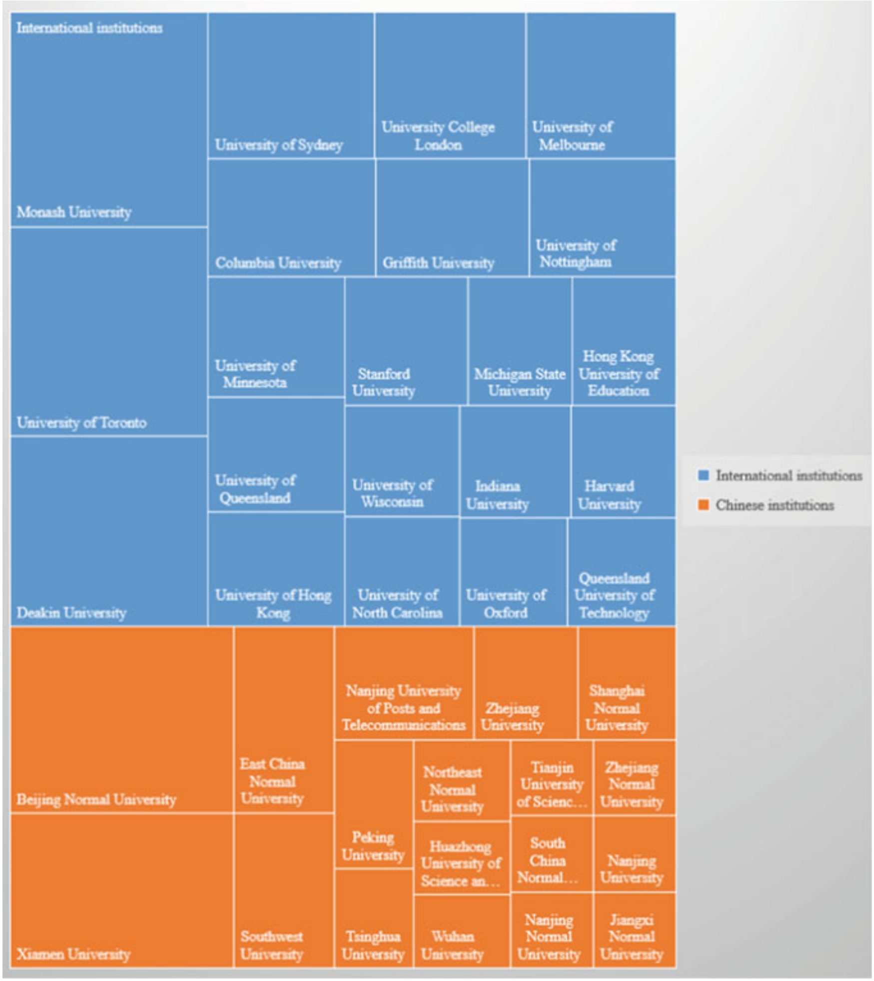

Fig. 7 Bar chart of major papers published in units from 2003–2021. *Source* Compiled from search results from CNKI and WOS

keyword clustering analysis, domestic scholars' concerns in the internationalization of education mainly include international education, internationalization, cooperative schooling, higher education, teacher training university, schooling mode, etc. The influence of WTO and Russia on international education in China is also widely discussed. Among them, higher education and cooperative education are the main topics in the internationalization research, which reflects the increasing demand for higher education in China.

As shown in Fig. 9, in the English literature, in the field of education internationalization, scholars have a higher focus on international students, international student mobility, international education, international development, international

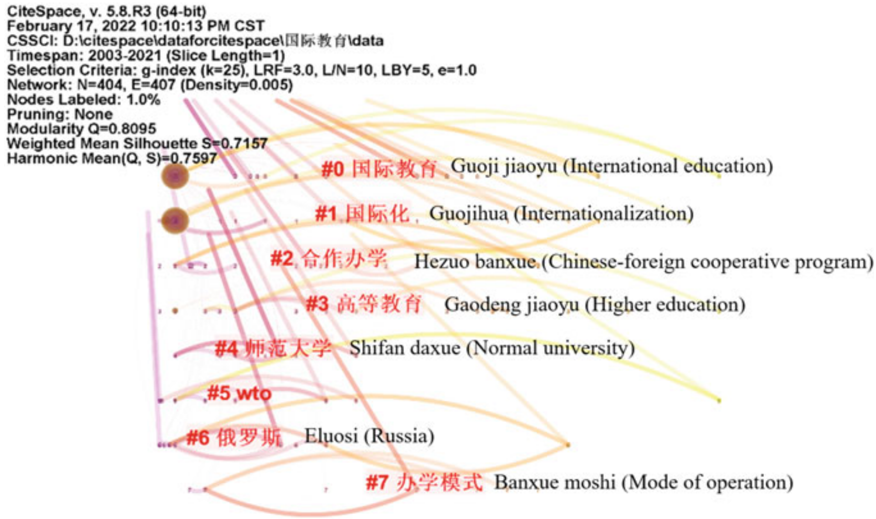

Fig. 8 CNKI keyword clustering view. *Source* Compiled from search results from CNKI

migration, and international higher education while also giving greater attention to global health and teachers' attitudes. Within education internationalization, English literature pays more attention to the micro-level by focusing on individual students and teachers while also maintaining a high focus on macro areas. In contrast, Chinese literature focuses on the analysis of macro areas.

A keyword analysis was conducted on both Chinese and English education internationalization literature. This analysis revealed that in the Chinese literature, domestic scholars pay more attention to the fields of international education, internationalization, higher education, cooperative education, globalization, bilingual teaching, and talent training. Among them, the centrality of national education, internationalization, and cooperative education in higher education is close to or more than 0.1. Compared with the English literature, keywords such as international education, higher education, international students, education, students, experience, university, and model come to the fore. On the one hand, it can be seen that there is a broad consensus in the national and international fields about the connection between international education and higher education and universities. On the other hand, the papers published in the international field pay more attention to the analysis of micro students than papers published in Chinese (Table 2).

In the analysis of expansion words, domestic literature does not have high-frequency words that have not appeared with smoother change frequency (i.e., the research heat in the field of internationalization of education lasts for a long time). While in the field of international research, the research hotspots that have gradually appeared since 2003 are education policy, developing countries, economic development, comparative education, and international education, among which education

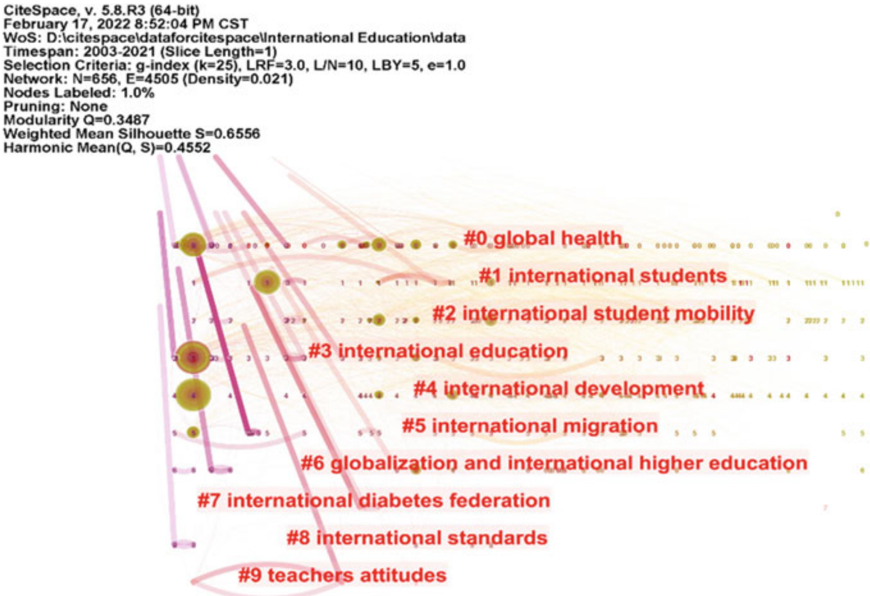

Fig. 9 WOS keyword clustering view. *Source* Compiled from search results from WOS

Table 2 CNKI keywords word frequency analysis table

Frequency	Centrality	CNKI keywords	WOS keywords	Centrality	Count
51	0.21	*Guoji jiaoyu*	International education	0.16	576
41	0.13	*Guojihua*	Higher education	0.04	555
23	0.09	*Gaodeng jiaoyu*	International student	0.05	457
19	0.09	*Hezuo banxue*	Education	0.1	394
18	0.04	*Quanqiuhua*	Student	0.06	200
11	0.03	*Shuangyu jiaoxue*	Experience	0.05	188
8	0.01	*Duice*	Impact	0.09	126
8	0.01	*Rencai peiyang*	University	0.02	126
8	0.03	*WTO*	Model	0.05	92
7	0.02	*Zhongwai hezuo*	Perception	0.02	91
6	0.02	*Gaozhi yuanxiao*	Knowledge	0.03	86
6	0.03	*Banxue moshi*	Challenge	0.04	84
5	0.01	*Shifan daxue*	Policy	0.03	83
5	0.02	*Zhiliang baozhang*	Study abroad	0.04	82
4	0.01	*Gongli daxue*	Teacher education	0.02	82

Source Compiled from search results from CNKI and WOS policy died down in 2015. Since 2010, international migration, social justice, inclusive education, and comparative international education gradually became hotspots, but none continued to 2020. In recent years, education adaptation research and PISA have continued to be of great concern (Fig. 10).

In terms of research themes, both domestic and international academics in the field of education internationalization pay much attention to macro- and meso-levels, such as international education, higher education, and cooperative schooling (overseas branches). At the same time, international scholars have similarly focused on individual micro levels such as international students' learning, mobility, and migration.

From 2003 to 2021, the scope of domestic scholars' concerns has expanded gradually on internationalization and related issues in the fields of vocational education,

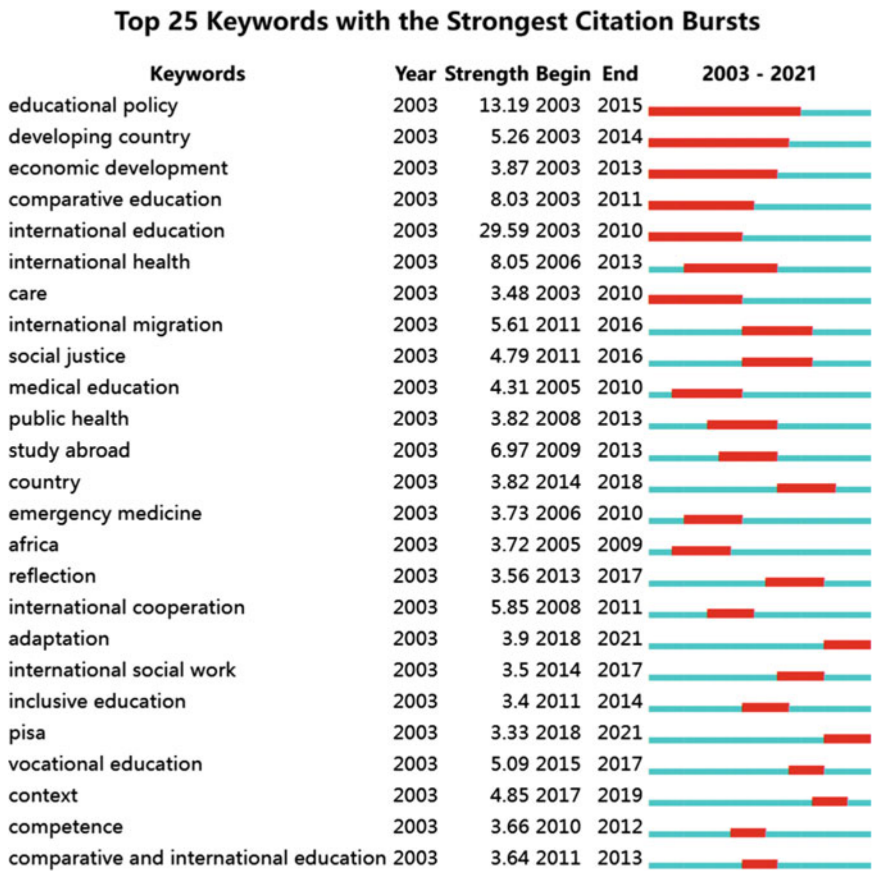

Fig. 10 Inflationary word analysis view

higher education, and international collaborative programs. Meanwhile, for internationalization, the analysis focuses on the relation between socio-economic development and education. The research and analysis of education policy has a more important role in both domestic and international publications, but the numbers of publications on international research declined after 20 years, and the attention of the international field to the adaptation of education and PISA has increased in recent years. On the other hand, the research of domestic scholars is closely related to the contemporary socio-economic context in which China is located, especially for the internationalization of education brought about by China's entry to WTO and the national relations between China and Russia.

In conclusion, it is shown in the analysis that the research on internationalization of education in China is still in an exploratory phase. There is a room for further expansion in the field of international research. Cooperation between domestic universities, international organizations, and international universities should be further strengthened. Domestic scholars should consider broadening their research focus beyond to also include vocational education and international student mobility.

7 National Policies

7.1 Fundamental Policies in Chinese International Education

In 2003, the State Council promulgated the first administrative regulation on Chinese-foreign cooperative education in the history of higher education in China. It provides detailed regulations on various aspects of international collaborative programs, including the purpose, nature, establishment conditions and steps, organization and management mechanism, education and teaching norms, assets and financial system, change and termination conditions, and legal responsibilities (Tan & Liu, 2019). The regulations clearly state that the state encourages the introduction of international high-quality educational resources of international collaborative programs. The government also encourages international collaborative programs in higher education and vocational education. At the same time, Chinese higher education institutions and their international counterparts are encouraged to cooperate in school administration.

The introduction of *Outline of the National Medium- and Long-term Education Reform and Development Plan (2010–2020)* (The State Council, 2010) and *Plan for Studying in China* (MOE, 2010) have promoted the steady growth of the number of international students studying in China. *Plan for Studying in China* was released to implement *Outline of the National Medium- and Long-term Education Reform and Development Plan (2010–2020)*, to strengthen educational exchanges and cooperation between China and abroad, to promote the sustainable and healthy development of study in China, and to improve the internationalization of China's education.

The *Plan for Studying in China* specifies development goals, main tasks, guiding ideologies, and working guidelines of the study in China program. This plan also clarifies the policies, institutions, mechanisms, publicity and promotion, admission and training modes, curriculum and teachers' construction and implementation, and puts forward requirements for education management and its team, living services and social practice. The *Plan for Studying in China* is the first strategic guidance plan for the education of international students, proposing the goal of reaching 500,000 international students by 2020. The issuance of the *Plan for Studying in China* in the new era sets a tone of change and direction for the field of education for international students coming to China (Zhao, 2021).

7.2 Policies Related to International Collaborative Programs

7.2.1 Essential Policies

In 1995, the former National Education Commission promulgated a temporary legal regulation for international collaborative programs in China (Tan & Liu, 2019). This regulation details the meaning, nature, necessity, principles to be followed, approval criteria and procedures, main bodies and leadership systems, certificate issuance and diploma awarding, and supervision system of international collaborative programs (Xiong & Chen, 2018). This document states that international collaborative programs are an important form of international exchange and cooperation in Chinese education and are complementary to Chinese education and that these regulations are formulated in order to strengthen the management of international collaborative programs and to promote the development of China's education and educational foreign exchange and cooperation. The regulation fully affirms the status and significance of international collaborative programs, builds a basic framework of international collaborative programs policy, and provides a policy basis for international collaborative programs to follow (Xiong & Chen, 2018).

In 2006, to further improve the quality of international collaborative programs at the undergraduate level and above, and to strengthen the standardized management, MOE emphasized the principle of public welfare of international collaborative programs. To better promote the steady and healthy development of international collaborative programs, MOE has put forward opinions on the current problems in international collaborative programs, emphasizing the need to adhere to the principle of public welfare, run the school according to the law, and strengthen the quality management and fee management of international collaborative programs (Tan & Liu, 2019).

In 2009, to further regulate management, improve quality, and promote the healthy development of international collaborative programs, MOE initiated the evaluation of international collaborative programs. The evaluation program conducts an assessment of international collaborative institutions and programs' establishment and operation. The assessment focuses on strengthening the supervision of international collaborative programs through the evaluation of the overall thinking, asset management, teaching quality, faculty construction, social evaluation, and the internal and external benefits of school unit. This work has strengthened the state's standardized management of international collaborative programs, promoted the operation of schools in accordance with laws, and improved the level and sustainable development of international collaborative programs (Xiong & Chen, 2018).

7.2.2 Recent Key Policies

In 2010, the Education International Exchange and Cooperation Project was included as one of the 10 major projects in China's 10-year development plan, reflecting the importance that China attaches to international collaborative programs (Tan & Liu, 2019). The outline seeks to attract renowned schools, educational and scientific research institutions, and enterprises from abroad to cooperate in establishing educational teaching, training, and research institutions or projects. The outline also encourages schools at all levels to carry out various forms of international exchange and collaboration and run a number of model international collaborative programs and a number of international collaborative projects, to explore a variety of ways of utilizing foreign high-quality educational resources. In 2016, new and higher requirements for international collaborative programs were put forward, emphasizing the need to vigorously improve the level of governance of education, opening up to the outside world and strengthening the organizational leadership of education opening up to the outside world (Xiong & Chen, 2018). In the same year, MOE proposed implementing the "Belt and Road" collaborative education promotion plan as an important element of the supporting framework for developing talent cultivation. This shows that international collaborative program, as an important part of China's education reform and development, is itself an essential part of China's education opening-up to the outside world. (Xiong & Chen, 2018).

7.3 Policies Related to International Students Coming to China

7.3.1 Essential Policies

In the 1960s and 1970s, accepting and cultivating international students was listed as a strategic task of China's foreign relations. This mission set up regulations for the management of international students, which includes the ideological and political work and political activity management, academic registration management, life management and social management, and organization and leadership. At the same time, this mission also focuses on international student experiences in

China, including enrollment, teaching, professional internship and social investigation. This document emphasizes the role of education for international students in China in promoting educational, scientific and technological, cultural exchanges and economic and trade cooperation between China and other countries in the world. The policy on education for international students in China has shown a clear political and diplomatic orientation. The policy first emphasizes fulfilling internationalist obligations and the promotion of cooperation and interaction between China and other countries in the world in various fields (Liu & Zhang, 2018).

In 2000, a systematic summary of the policy adjustments and management practices of education in China after the reform and opening-up was issued, which also provided a forward-looking view and institutional arrangement for the development of education in China in the new century. In order to enhance the understanding and friendship between China and people all over the world, promote international exchange and cooperation between higher education institutions, and strengthen the standard management of accepting and cultivating international students, the regulations clarify the management responsibilities of local authorities and schools, and establish the management system of coordinated management by MOE, coordinated management by local education administrative departments, and independent management by schools (Liu & Zhang, 2018).

7.3.2 Recent Key Policies

In 2016, two policy documents were issued to promote the growth rate of students coming to China to reach a new peak. These documents call for accelerating the development of study abroad and improving the quality of study abroad education. It is proposed optimizing the layout of countries and majors of international students, increasing the construction of branded majors and branded courses, building a socialized and specialized service system, and creating the brand of Studying in China. This indicates that the policy on education for studying in China has paid more attention to internal development (Zhao, 2021).

In 2018, a systematic and specific regulation focusing on international students' talent cultivation, enrollment and admission, education and teaching, and management and service support was issued, which clearly states that the quality assurance of international students' education should be continuously improved. The education of international students in China basically shows the characteristics of education-oriented and begins to pay more and more attention to the quality of education (Zhao, 2021). The regulation aims to guide the activities of higher education for international students and continuously improve the quality of higher education for international students and is the basic guideline for higher education institutions to carry out education for international students. It is essential for higher education institutions such as colleges and universities to improve the internal quality assurance of higher education for international students. This includes both self-evaluation and the basis for various educational evaluation organizations to evaluate higher education for international students.

In 2020, additional regulations were issued on the acceptance of international students by higher education institutions to study at the undergraduate level and require higher education institutions to strictly examine the nationality status and eligibility of international students applying for admission in accordance with the law. This change seeks to maintain the fairness of higher education in China and to further restrict the eligibility of international students to apply for admission to study at the undergraduate level in Chinese higher education institutions (MOE, 2020b). According to Chen Zhiwen, executive director of the China Association for International Education Exchange, the revised regulation has improved the higher education system (Li, 2020). This is part of the efforts to improve the quality of international students coming to China. From the perspective of the college entrance examination, it is a major step to ensure the fairness and impartiality of the college entrance examination (Li, 2020).

7.4 Policies Related to Overseas Talent Recruitment to China (National Level)

7.4.1 Essential Policies

In 1994, the state established the National Outstanding Young Scientists Fund, thereby promoting the growth of young scientific and technological talents, encouraging overseas scholars to return to work in China, and accelerating the training of a group of outstanding academic leaders who will enter the frontier of science and technology in the world. Applicants include young Chinese scholars and young scholars from outside the People's Republic of China. The National Outstanding Young Scientists Fund program supports young scholars who have made outstanding achievements in basic research, enabling them to choose their research directions to carry out innovative research. This has greatly facilitated the growth of young scientific and technological talents and attracted overseas talents while nurturing several outstanding academic leaders who have entered the frontiers of world science and technology (Cheng, 2014).

Furthermore, China has launched policy measures fostering the innovation and entrepreneurship of overseas students. It has also launched the demonstration construction of the national overseas students' entrepreneurship parks in 2000 and issued relevant guidance in 2001. These policy initiatives have stimulated the enthusiasm of overseas students to return to China for innovation and entrepreneurship and become an important push to guide overseas students to return to China for innovation and entrepreneurship (Sun & Wang, 2010).

7.4.2 Recent Key Policies

The official implementation of the Thousand Talents Program by the Ministry of Organization in 2008 became a milestone in the field of overseas talent introduction policy in China. This means that China has started to participate in the competition for international talents in all aspects and has been recognized as a national priority. There is an urgent need to vigorously introduce high-level international talents to expand the opening up to the outside world and improve international competitiveness further. It is a major initiative to thoroughly implement the scientific development concept, build an innovative country, and achieve the goal a prosperous society. China focuses on the strategic goals of national development through four platforms: national innovation projects, key disciplines, key laboratories, central enterprises and state-owned financial institutions, and various parks mainly for developing high-tech industries. China supports scientists and leading talents who can break through key technologies, develop high-tech industries, and drive emerging disciplines to return to China for innovation and entrepreneurship.

In 2010, the *Outline of the National Medium- and Long-term Education Reform and Development Plan (2010–2020)* points out that talent is the first resource for China's economic and social development. It also clearly proposed a more open talent policy, elaborated the goal of talent team building, presented institutional and institutional innovation, significant policies, major talent projects, standardized the organization and implementation process. By 2020, the overall goal of China's talent development is: to cultivate and create a large scale, optimized structure, reasonable layout, excellent quality talent team, establish the country's comparative advantage in the talent competition, enter the ranks of the world's talent power, and lay the foundation of talent for the basic realization of socialist modernization in the middle of this century (Guan, 2013).

8 Summary

The development of international education plays an important role in the globalization of the Chinese education system and the cultivation of innovative talents. Since the reform and opening-up, the development of international education in China has promoted international cooperation in research and innovation, cultivated a large number of advanced talents in highly sophisticated industries, enhanced the international influence of Chinese universities, and played a significant role in the economic and social development of China.

This chapter provides a global comparison of international education. The first part of this chapter provides a working definition of international education for this chapter as well as an overview of international education in China and then compared the situation of global education mobility with China's case. Despite the enduring impact of the pandemic on educational mobility in China and around the world, from an overall perspective, the number of Chinese students studying abroad and international students coming to China has been steadily increasing during the past decades, and the international collaborative program system has been improved greatly after a series of reforms.

Drawing upon statistics generated from government websites, official yearbooks, and academic reports, the results presented in this chapter demonstrate that China has effectively promoted the development of international education and international research collaboration during the past few decades, and has achieved comparable results with top universities in the world, in terms of the overseas campus, overseas research center, exchange program, international faculty ratio, international joint publication, international student ratio, student mobility, and international doctorate degrees. In terms of the student and faculty-related indicators, Chinese universities have further opportunities for growth, considering the percentage of international students and faculty in Chinese universities is still low.

The second part of this chapter introduces the development of international education in China from four aspects, including best practices of international education, stories of inspiring international collaborations, latest research in international education, and overview of fundamental and key policies in international education.

Through best practice sharing, the chapter introduces how China, as a latecomer in this inexorable international trend, blazed its own trail and successfully moved from the periphery to the center of the higher educational international arena. Among the numerous strategies used to attain this goal, this chapter focuses on faculty internationalization and internationalization at home, two representative means done by Chinese higher education institutions (HEIs) to meet this end. Then, this chapter presents three inspiring individuals' stories, respectively, Xiao Xuehua, the Gen Z leader of Chinese overseas students; Cao Wen, a pilot in China's international education; and Cheng Yan Davis, a bridge-builder of international initiatives to document the remarkable moments in the development of international education in China.

Finally, this chapter presents the reform and developments of international education in China from diverse aspects, and demonstrates how China has made its way from zero to one of the major countries of origin and destination of international mobility. The efforts of government departments, higher education institutions, and every student and teacher involved in the internationalization process are crucial to the development of international education in China. This chapter suggests that the continuous improvement of relevant policies, the strengthening of regulatory mechanisms and the gradual deepening of China's international exchanges strategies have jointly promoted the development of international education in China. International education has an increasingly important role to play in promoting the cultivation of international talents and facilitating cultural exchanges between China and the world.

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Chapter 12
Global Comparison of Excellence Initiatives

Feng Zhuolin, Guo Xin, and Jia Xintong

Abstract Since the end of the 1980s, many countries around the world have been committed to building world-class universities to strengthen their competitiveness in the global higher education market. These excellence initiatives, initiated by China and a few other countries, have contributed significantly to enhance these countries' higher education capacity. This chapter focuses on the comparison of excellence initiatives and relevant policies among China and other countries, including highlighting data, excellence indicators, best practices, and relevant national policies. Moreover, it analyzes the latest research and shares inspiring stories about China's experience in developing academic excellence. The quantitative measures of Chinese universities funded by the Double World-Class Project have increased significantly, but it has taken them a long time to gain the soft power that matches their world rankings. While global excellence initiatives tend to integrate with national strategies to develop higher education and share same global visions, there are differences in terms of implementation measures or plans among countries that will be explored in this chapter. In the future, excellence initiatives will place more emphasis on international development as well as the will of the state.

Keywords Excellence initiatives · World-class university · Global comparison

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1 Introduction

1.1 The Origin and Development of Excellence Initiatives

In the time of intense global competition, a nation's competitiveness relies on its scientific and technological progress and knowledge innovation. Advancing the development of higher education and establishing world-class universities and leading research universities are key to guaranteeing the initiative of a nation, and rapidly improving the quality of skilled workforce and the strength of scientific and technological innovation (Liu & Li, 2011). Since the end of 1980s, more than 40 countries and regions around the world have implemented excellence initiatives to develop world-class universities or disciplines (Feng & Liu, 2019). These policies usually include excellence initiatives for universities, research institutions, field research, personnel, and school-enterprise cooperation.

Governments at all levels play an important role in designing and implementing these excellence initiatives. They provide centralized funding for universities or disciplines with advantage and potential to achieve excellence, so as to further enhance its higher education capacity in the global competition. In other words, most excellence initiatives share three main features: a top-down approach in policy implementation, centralized funding, and a strong focus on international academic excellence (Feng et al., 2017). Countries that invest in excellence initiatives span all seven continents across the globe, regardless of their socio-economic status. Countries with strong higher education systems are committed to consolidating their existing performances and continuously expanding their advantages in the global education market. Countries with strong higher education foundations are committed to forming and improving international competitiveness, seeking to climbing up the global echelon. Other countries are committed to making an international influence through conducting international research, so as to make their voices heard in global society. It is worth noting that higher education has been impacted by global crises in recent years, such as the ongoing global pandemic, rising nationalism, terrorism, and financial crisis, leading to changes in excellence initiatives globally. Instead of allocating funding and support evenly in all aspects, countries focus on building world-class universities or disciplines based on their existing advantages.

1.2 Excellence Initiatives Around the World

1.2.1 Regional Distribution of Excellence Initiatives Around the World

More than 40 countries or regions around the world have implemented various excellence initiatives. The world-class movement has become a global consensus to some extent. In terms of geographical distribution, excellence initiatives are mostly adopted in Europe and Asia. Nearly 20 countries in Europe, represented by Germany, France, and Denmark, have developed excellence initiatives; nearly 10 countries in Asia, represented by China, Japan, the Republic of Korea (hereafter ROK), India, and Vietnam, have implemented initiatives and strategies to develop excellence. In comparison, the number of excellence initiatives in Oceania, North America, and other regions is relatively small.

Some countries in Northern Europe were among the very first to develop academic excellence. In the beginning of the 1990s, Denmark started the Centers of Excellence program, which aimed to strengthen Danish research by providing the best working conditions and organizational set-up for top researchers (Danish National Research Foundation, 1991). Many other countries in Europe followed closely and developed their own initiatives. For example, in 2005, German federal and state governments intended to enhance the graduate education sector and research institutions through the special funding project–Excellence Initiative and strived to construct a group of "excellent universities" (German Research Foundation, 2005). In 2010, French government issued Initiatives d'Excellence (Initiative of Excellence, hereafter IDEX), which focused on advancing technological innovation and technical transfer, and to construct five to 10 world-class universities with international competitiveness (Ministry of Education [MOE] of France, 2010a). Russian government launched the Project 5–100 in 2013, which aimed to have five universities reach the top 100 in the world by 2020. The goal of Project 5–100 is to reform higher education research and teaching and to enhance the country's global competitiveness (Ministry of Education and Science of the Russian Federation, 2013).

Asian countries with relatively strong higher education systems also strive to maintain and improve their competitiveness by implementing excellence initiatives. In 2007, Japan launched the World Premier International Research Center Initiative, which focused on advancing cutting-edge research, establishing interdisciplinary fields, creating an international research environment, and reforming research organizations (Japan Society for the Promotion of Science, 2007). Some emerging economies in Asia regard higher education as a breakthrough and try to enhance their international influence by implementing excellence initiatives. In 1997, India launched two projects, Universities with Potential for Excellence (hereafter UPE) and Centers with Potential for Excellence in certain disciplinary areas, which aimed to enhance universities' research and teaching excellence, promote innovative research in interdisciplinary and multidisciplinary fields, and improve their status and become a leader in specific fields within a short period of time (University Grants Commission, 1997a). In 2008, Vietnam began to implement the New Model University Project, and the plan aimed to establish high-quality "new model universities". Different from highly-centralized projects in the past, this new project is more flexible in terms of its management and organization, so as to develop students' innovative skills and help universities quickly meet international standards (Ministry of Education and Training of Vietnam, 2008).

1.2.2 Time Distribution of Excellence Initiatives Around the World

The development of excellence initiatives across the world can be divided into three stages: early development (1989–2000), steady growth (2001–2010), and accelerating expansion (2011–2020) (Feng & Liu, 2021).

Before the twenty-first century, the concept of globalization was still in the process of being formed, and excellence initiatives were pretty much in their early development and only a few countries had carried out plans to develop world-class universities or disciplines. Denmark launched its project, Centers of Excellence, in 1991 to provide top researchers with the best environment for teaching and research and improve its scientific research capacity. The project's selection was flexible and allowed interdisciplinary cooperation (Danish National Research Foundation, 1991). In the late 1990s, some developing countries also joined the race for world-class universities and disciplines. For example, China and India implemented programs of building excellent universities in 1995 and 1997 respectively, both aiming to provide substantive funding for universities with potential and to improve their competitiveness in the world (National Education Commission, 1995; University Grants Commission, 1997a).

After stepping into the twenty-first century, the development of excellence initiatives has been in steady growth. In particular, the emergence of third-party assessments, such as world university rankings, provided countries with a more intuitive way of comparing higher education capacity and further stimulated international competition. Under the increasingly fierce competition, a few developed countries intended to further reinforce their advantage, and some realized their stagnation and sought to revive their institutions; while emerging economies strived to gain visibility on the global stage. During this time, both developed and emerging countries started various types of projects to develop academic excellence.

After a decade of reform efforts, some countries have achieved initial success in developing world-class universities or disciplines, and excellence initiatives have entered a stage of accelerating expansion. More and more countries have implemented relevant policies and strategies on developing excellence, and many countries have successively launched follow-up plans based on the performance and progress of their previous excellence initiatives.

1.3 China's Excellence Initiatives

Chinese higher education has made remarkable progress in the past 30 years, due to Chinese government's attention and support as well as its universities' persistent efforts. Education is regarded as an important national strategy in China and Chinese government has formulated a series of significant long-term plans and initiatives to construct key universities, such as Project 211, Project 985 and the Double World-Class Project. The overall development plan for Project 211 and Project 985 mainly included promoting educational innovation, strengthening the scientific research function of universities, and promoting the internationalization of higher education. *The Overall Plan for Promoting the Construction of World-Class Universities and World-Class Disciplines* was published in 2015, which clearly set the development goals of Chinese higher education: by the middle of the twenty-first century, it will develop top Chinese universities into world-class institutions (Liu et al., 2021).

1.3.1 Project 211

Before the reform and opening-up in 1978, Chinese government had selected several universities as national key universities, but the systematic projects of constructing world-class universities or disciplines did not start until Project 211 launched in 1995. Project 211 aimed at developing about 100 key universities and a number of key disciplines by the early twenty-first century. The project strived to "make some key universities and key disciplines be close to or reach the advanced level of the world, improve the conditions of universities, and make great achievements in talent training and scientific research" (National Education Commission, 1995). This funding scheme mainly focused on four aspects of development: disciplinary and interdisciplinary programs, digital campuses, faculty excellence, and university infrastructure. Compared with other key state projects since the founding of the new China, it was not only the largest scale project in the field of higher education but also the highest level of block grant at that time. Altogether, 116 universities were selected throughout the three phases of the project (Office of the Inter-Ministerial Coordination Group of Project 211, 2003).

With the support of the project, infrastructure and other conditions improved significantly at the selected universities, remarkably enhancing the overall strength of the universities. More importantly, the project inspired Chinese universities to compete internationally, and encouraged the thinking of universities on further developing world-class academic excellence (Wang & Cheng, 2014). However, there was still a large gap between China's top universities and their international peers, in terms of faculty, teaching and research quality, and knowledge creation and innovation. To further narrow the gap and enhance public funding for higher education, Chinese government launched Project 985.

1.3.2 Project 985

Project 985 was launched in 1998 to develop a tertiary education system of international standing. This project was funded through block funding and resources from Chinese government as well as from other ministries and departments. The project intended to establish a number of world-class universities and to develop a number of key research centers of excellence within 10–20 years (MOE, 1998). Project 985 was implemented in three phases: 1999–2003, 2004–2009, and 2010–2015. Altogether, 39 universities were selected by Chinese government.

Project 985 is of great historical and practical significance to China's development of modernization and international competitiveness. As an integral part of the national talent development strategy, this project is not only conducive to improving the overall strength of China's higher education, contributing to the country's economic, social and cultural development, but also conducive to the exchange and mutual learning between Chinese culture and other countries (MOE & Ministry of Finance, 2004).

1.3.3 The Double World-Class Project

The Double World-Class Project is the third project to develop academic excellence after Project 211 and Project 985. In 2015, the State Council issued *The Overall Plan for Promoting the Construction of World-Class Universities and World-Class Disciplines*, and put forward the following goals: to develop a number of world-class universities and first-class academic disciplines by 2020; to have more universities and disciplines among the world's best and to enhance the country's overall higher education capacity by 2030; and to lead the number, quality and capacity of world-class universities and disciplines among the world's best, becoming a higher education powerhouse by 2050.

This project encourages diversified development of leading universities of various types (such as research universities, teaching universities, and art and music conservatories). It emphasizes performance evaluations and adopts a dynamic evaluation and funding approach to reward the high-performing institutions while eliminating under-performing institutions. The duration of each round is five years. The project selects 42 universities to participate in the first round, of which 36 are Class A and six are Class B, and 140 universities are designated to develop world-class disciplines (MOE et al., 2017a). World-class universities focus on the overall construction of the institution based on world-class disciplines and the comprehensive improvement of talent training and innovation ability, while universities designated to develop world-class disciplines focus on developing quality disciplines and forming the institution's features and identities.

The first round of the Double World-Class Project was completed in 2020. In 2022, the list of selected universities of the second round was published: the number of universities was increased to 147, while the list of the first-round of disciplines to be publicly warned (including revoked) was also published (MOE et al., 2022a). Different from the first round, the second round no longer distinguishes world-class universities and universities designated to develop world-class disciplines, but "emphasizes exploring the establishment of diversified development, diversified support, and diversified evaluation, and guides universities to focus on the innovation and breakthrough in relevant fields and directions, so as to create truly world-class universities" (MOE, 2022).

2 Highlighting Data

This section compares China's Double World-Class Project with excellence initiatives of 10 countries. The following countries and excellence initiatives were selected:

- Australia: ARC Centers of Excellence (ARC refers to Australian Research Council)
- Denmark: Centers of Excellence
- Finland: Centers of Excellence
- France: Initiative of Excellence (IDEX)
- Germany: Excellence Initiative
- Israel: Israeli Centers of Research Excellence (hereafter I-CORE)
- Japan: Top Global University Project
- ROK: Brain Korea 21 Plus (hereafter BK21 Plus)
- Russia: Project 5–100
- Vietnam: New Model University Project.

2.1 Number of Higher Education Institutions Funded by Each Excellence Initiative

In 2017, China officially launched the first round of the Double World-Class Project, in which 42 universities were selected aiming to become world-class and 140 universities were designated to develop world-class disciplines (MOE et al., 2017a). In 2022, 147 universities were selected in the second round of the Double World-Class Project (MOE et al., 2022a). The average number of higher education institutions (hereafter HEIs) funded by excellence initiatives in the other 10 countries (excluding China) is 19 (Fig. 1).

The number of HEIs funded by ROK and Japan's excellence initiatives is relatively large. ROK's MOE strictly examined 345 discipline clusters (large-scale units) and 866 discipline groups (small-scale units) which applied by 108 universities, and finally selected 195 discipline clusters and 280 discipline groups from 64 universities for the BK21 Plus project (MOE of ROK, 2013). The funded disciplines cover various academic fields, including natural science, technology, humanities, and social science, and the project targets at training global talents, specialized talents and innovative future talents (*ibid*). Japan's Top Global University Project received 109 applications from 104 universities. The committee reviewed these applications based on three criteria: internationalization, management, and education reform, and finally selected 37 universities, including 13 Class A universities and 24 Class B universities (MEXT of Japan, 2014a).

Most countries' excellence initiatives fund about 10–20 HEIs. Russia's Project 5–100 has funded a total of 21 universities, with 15 universities funded in the first cycle and an additional six universities added to the second funding cycle (Ministry of

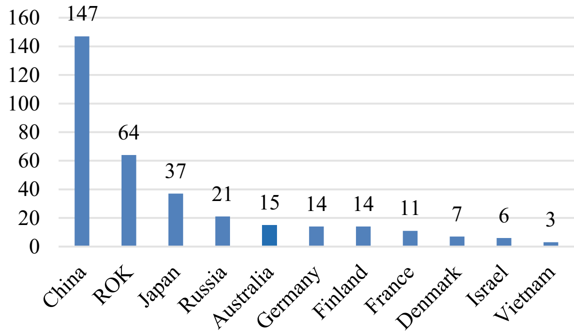

Fig. 1 Number of higher education institutions funded by each excellence initiative. *Source* MOE et al. (2017a), MOE of ROK (2013), Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT of Japan) (2014a), Ministry of Education and Science of the Russian Federation (2013), Australian Research Council (2009), German Research Foundation (2005), Academy of Finland (1995), MOE of France (2010a), Danish National Research Foundation (1991), Planning and Budget Committee of Israel (2011), Ministry of Education and Training of Vietnam (2008)

Education and Science of the Russian Federation, 2013). Australia's ARC Centers of Excellence has launched four phases, with 15 universities funded in total (Australian Research Council, 2009). Germany's Excellence Initiative has funded a total of 14 universities, with nine universities funded in the first round and 11 universities funded in the second round. Some universities, however, have received funding in both rounds (German Research Foundation, 2005). Finland's Centers of Excellence has funded 14 universities (Academy of Finland, 1995). France's IDEX has funded altogether 11 universities in two phases (MOE of France, 2010a).

The number of HEIs funded by Denmark, Israel, and Vietnam's excellence initiatives is relatively smaller. As the total number of universities in Denmark and Israel is small, the number of funded universities in the two countries is small as well. Denmark's Centers of Excellence has funded seven universities (Danish National Research Foundation, 1991); Israel's I-CORE has funded six universities (Planning & Budget Committee of Israel, 2011). The strength of higher education of Vietnam is not as strong as other countries, and this limitation may affect the universities funded by New Model University Project, as the number is only three (Ministry of Education and Training of Vietnam, 2008).

2.2 *Funded Institutions as a Percentage of Total Higher Education Institutions*

With the continuous expansion of China's higher education, the total number of Chinese universities has reached 2,738 (MOE, 2021b), and the percentage of universities funded by the Double World-Class Project is about 5.37%. For other 10 countries, the average percentage of HEIs funded by excellence initiatives in the total HEIs is about 10.88% (Fig. 2).

The percentage of HEIs funded by Finland, Denmark, and ROK's excellence initiatives is relatively higher. In Finland, the total number of universities is only 35, so the number of funded universities is not large, but the percentage reaches 40% (Ministry of Education and Culture of Finland, 2022), which is the highest among the 11 countries. Universities funded by Centers of Excellence account for 18.42% in the total 38 universities in Denmark (Study in Denmark, 2022). Universities funded by BK21 Plus account for 15.02% in the total 426 universities in ROK (MOE of ROK, 2021).

The percentage of HEIs funded by Israel and Australia's excellence initiatives are close to the average. The number of universities funded by I-CORE is not large, but it accounts for 10.17% of the total 59 universities of Israel (Israel Council for Higher Education, 2022). The universities funded by ARC Centers of Excellence account for 8.82% of the total 170 universities of Australia (Universities Australia, 2022).

The proportions of HEIs funded by Japan, France, Germany, Russia, and Vietnam's excellence initiatives are relatively low, and they are all lower than China's figure (5.37%). According to the statistics of the *2021 Basic Survey of Schools* released by the MEXT of Japan, the total number of Japanese universities in 2021 is

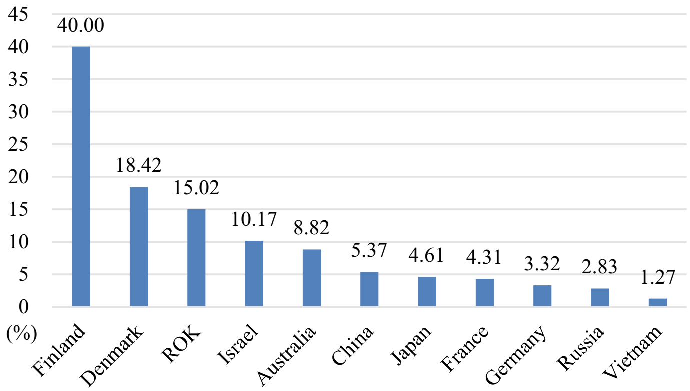

Fig. 2 Funded institutions as a percentage of total higher education institutions(%). *Source* Ministry of Education and Culture of Finland (2022), Study in Denmark (2022), MOE of ROK (2021), Israel Council for Higher Education (2022), Universities Australia (2022), MOE et al. (2017a), MOE (2021a), MEXT of Japan (2021b), MOE of France (2022), Ministry of Education and Research of Germany (2022), Study in Russia (2022), Ministry of Education and Training of Vietnam (2021a)

803 (MEXT of Japan, 2021b), and the universities funded by Top Global University Project account for 4.61%. Some European countries, including France, Germany, and Russia, have similar proportions of funded universities, ranging from 2 to 5%. Universities funded by IDEX make up 4.31% of the total 255 universities of France (MOE of France, 2022). Universities funded by Excellence Initiative make up 3.32% of the total 422 universities of Germany (Ministry of Education and Research of Germany, 2022). Universities funded by Project 5–100 make up 2.83% of the total 741 universities of Russia (Study in Russia, 2022). The percentage of universities funded by New Model University Project of Vietnam is only 1.27% (Ministry of Education & Training of Vietnam, 2021a), which is the lowest among the 11 countries.

2.3 Duration of Excellence Initiatives

The planning of China's Double World-Class Project started from 2015, as planned, and it will continue to the middle of this century (the State Council, 2015). The goal is to improve the strength of leading universities and disciplines at the forefront of the world, and to build China as a powerful country in higher education (the State Council, 2015). The duration of the Double World-Class Project is about 35 years. The average duration of excellence initiatives of the other 10 countries is about 15 years (Fig. 3).

Denmark and Finland have the longest durations of excellence initiatives, which are more than 30 years, similar to China. Denmark's Centers of Excellence is planned

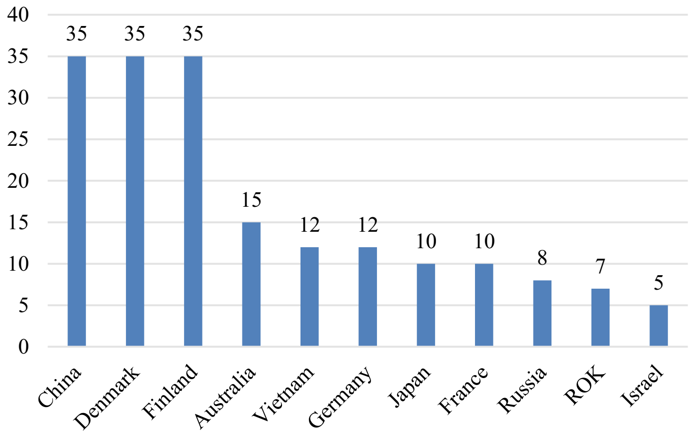

Fig. 3 Duration of excellence initiatives (year). *Source* the State Council (2015), Danish National Research Foundation (1991), Academy of Finland (1995), Australian Research Council (2009), Ministry of Education and Training of Vietnam (2008), German Research Foundation (2005), MEXT of Japan (2014a), MOE of France (2010a), Ministry of Education and Science of the Russian Federation (2013), MOE of ROK (2013), Planning and Budget Committee of Israel (2011)

for 35 years from 1991 to 2026 (Danish National Research Foundation, 1991). Finland's Centers of Excellence is planned to be implemented from 1995 to 2029, with a duration of 35 years (Academy of Finland, 1995).

Countries with a duration of 10–15 years include Australia, Vietnam, Germany, Japan, and France. Australia's ARC Centers of Excellence is planned for 15 years from 2009 to 2023 (Australian Research Council, 2009). Vietnam's New Model University Project has been implemented for 12 years from 2009 to 2020 (Ministry of Education and Training of Vietnam, 2008). Germany's Excellence Initiative has been implemented for 12 years, with the first round from 2007 to 2012 and the second round from 2012 to 2017 (German Research Foundation, 2005). Japan's Top Global University Project is planned for 10 years from 2014 to 2023 (MEXT of Japan, 2014a). France's IDEX has been implemented for 10 years, with the first phase from 2012 to 2016 and the second phase from 2018 to 2022 (MOE of France, 2010a).

Countries with a duration that is less than 10 years include Russia, ROK, and Israel. Russia's Project 5–100 has been implemented for eight years from 2013 to 2020 (Ministry of Education and Science of the Russian Federation, 2013). ROK's BK21 Plus has been implemented for seven years from 2013 to 2020 (MOE of ROK, 2013). Israel's I-CORE has been implemented for five years from 2011 to 2016 (Planning & Budget Committee of Israel, 2011), of which the duration is the shortest among the 11 countries.

2.4 Funding Period of Excellence Initiatives

China's Double World-Class Project takes a five-year round. The first round was from 2017 to 2021, and the second round started from 2022. The average funding period of the other 10 countries' excellence initiatives is about seven years (Fig. 4).

Those above the average include Vietnam, Japan, Denmark, ROK, and Finland's excellence initiatives. New Model University Project in Vietnam takes a 12-year cycle (Ministry of Education and Training of Vietnam, 2008). Japan's Top Global University Project has been implemented for a single ten-year phase (MEXT of Japan, 2014a). Denmark's Centers of Excellence has a 10-year cycle (Danish National Research Foundation, 1991). ROK's BK21 Plus has a seven-year cycle (MOE of ROK, 2013). Finland plans to implement Centers of Excellence from 1995 to 2029, with a six-year cycle in the early stage and an eight-year cycle in the subsequent stages (Academy of Finland, 1995), and the average funding period is about seven years.

Those with funding periods below the average include Germany, France, Russia, Australia, and Israel's excellence initiatives. Excellence Initiative in Germany lasts six years as a round (German Research Foundation, 2005). France's IDEX lasts five years as a phase (MOE of France, 2010a). Russia's Project 5–100 has been implemented for eight years from 2013 to 2020, with a four-year cycle (Ministry of Education and Science of the Russian Federation, 2013). Australia's ARC Centers of Excellence and Israel's I-CORE have three-year cycles (Australian Research Council,

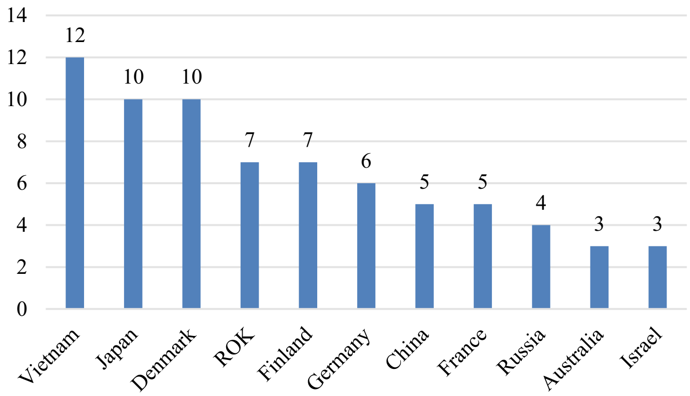

Fig. 4 Funding period of excellence initiatives (year). *Source* Ministry of Education and Training of Vietnam (2008), MEXT of Japan (2014a), Danish National Research Foundation (1991), MOE of ROK (2013), Academy of Finland (1995), German Research Foundation (2005), the State Council (2015), MOE of France (2010a), Ministry of Education and Science of the Russian Federation (2013), Australian Research Council (2009), Planning and Budget Committee of Israel (2011)

2009; Planning & Budget Committee of Israel, 2011), which is the shortest funding period among the 11 countries.

2.5 *Total Funding Amount for Excellence Initiatives*

In order to support the deep development of higher education, China's Ministry of Finance has set up a special fund for constructing world-class universities and disciplines and guiding characteristic development (Ministry of Finance, 2020). The fund has been steadily sustaining the development of the Double World-Class Project. From 2016 to 2020, RMB91.9 billion (Ministry of Finance, 2020), equivalent to US$13 billion, has been allocated to the Double World-Class Project, and the amount is the highest among the 11 countries. The average funding amount for excellence initiatives in the other 10 countries is about US$1.94 billion (Fig. 5).

France and Germany's funding amounts for excellence initiatives are significantly higher than the other eight countries. The funding for France's IDEX is about EUR 7.7 billion (US$8.55 billion) (MOE of France, 2010b). The funding for Germany's Excellence Initiative is about EUR 4.6 billion (US$5.26 billion), of which EUR 1.9 billion is invested in the first round and EUR 2.7 billion is invested in the second round; the state governments of the funded universities provide 25% of the funding and the federal government provides 75% (German Research Foundation, 2005). MOE of ROK and the National Research Foundation of ROK have invested about KRW 1910.3 billion (US$1.46 billion) in BK21 Plus (MOE of ROK, 2013). The funding for Russia's Project 5–100 is about RUB 60.5 billion (US$1.02 billion) (Ministry of Education and Science of the Russian Federation, 2013).

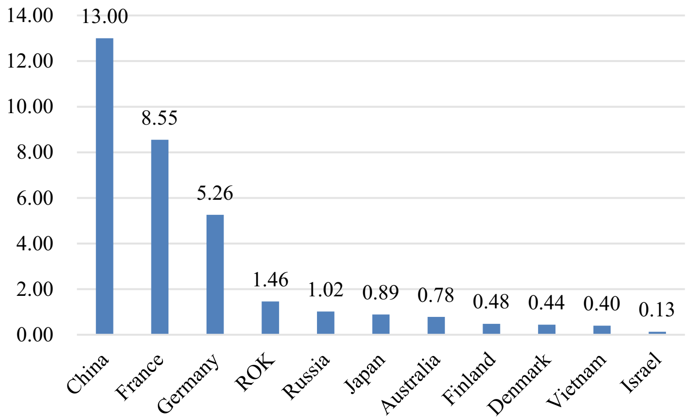

Fig. 5 Total funding amount for excellence initiatives (in US$ billion). *Source* Ministry of Finance (2020), MOE of France (2010b), German Research Foundation (2005), MOE of ROK (2013), Ministry of Education and Science of the Russian Federation (2013), Xiong and Chen (2020), Australian Research Council (2009), Academy of Finland (1995), Danish National Research Foundation (1991), Ministry of Education and Training of Vietnam (2008), Planning and Budget Committee of Israel (2011). *Notes* 1. As the funding amount of some periods is unavailable, the total funding amount is calculated based on the funding of the following period: China 2016–2020, France 2012–2016, Germany 2007–2017, ROK 2013–2020, Russia 2013–2017, Japan 2014–2020, Australia 2009–2020, Finland 1995–2019, Denmark 1993–2020, Vietnam 2011–2020, and Israel 2011–2016. 2. The exchange rate used in Fig. 5 is the exchange rate of the latest year of which the funding amount is available

Other countries have invested less than US$1 billion. The funding for Japan's Top Global University Project is about JPY 96 billion (Xiong & Chen, 2020), equivalent to US$0.89 billion. Australia has invested about AUD 1.13 billion (US$0.78 billion) in ARC Centers of Excellence (Australian Research Council, 2009). The funding amounts of Finland and Denmark are close, with about EUR 0.42 billion (US$0.48 billion) and EUR 0.39 billion (US$0.44 billion) respectively (Academy of Finland, 1995; Danish National Research Foundation, 1991). In 2009, Vietnamese government loaned US$0.4 billion from the World Bank and the Asia Development Bank for the construction of New Model University Project (Ministry of Education & Training of Vietnam, 2008). I-CORE of Israel was ratified by Israeli government and adopted by Council for Higher Education in 2010; the Planning and Budget Committee of Israel and the Israel Science Foundation jointly operate it (Planning & Budget Committee of Israel, 2011). The funding for I-CORE is ILS 0.45 billion, equivalent to US$0.13 billion (Planning & Budget Committee of Israel, 2011).

2.6 Total Funding for Excellence Initiatives as a Proportion of Total GDP in the Corresponding Period

During the period of the first round of the Double World-Class Project (2016–2020), China's total GDP is about US$66.43 trillion (World Bank, 2022), and the total funding of the Double World-Class Project accounts for 0.20‰. As for the other 10 countries, the average proportion of the grant funding in their total GDP is about 0.15‰ (Fig. 6).

During the period of the first phase of IDEX (2012–2016), France's total GDP is about US$13.25 trillion (World Bank, 2022), and the funding for IDEX makes up 0.65‰, which is the highest proportion among the 11 countries. Countries with proportions ranging from 0.10‰ to 0.20‰ include Vietnam (0.20‰), Germany (0.13‰), ROK (0.12‰) and Russia (0.12‰). Countries with proportions lower than 0.10‰ include Finland (0.09‰), Israel (0.07‰), Denmark (0.06‰), Australia (0.05‰), and Japan (0.03‰). During the first seven years of the implementation of Top Global University Project (2014–2020), the total GDP of Japan reaches about

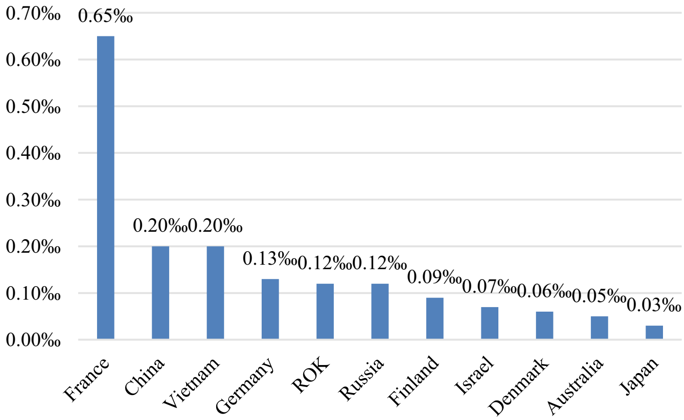

Fig. 6 Total funding for excellence initiatives as a proportion of total GDP in the corresponding period (‰). *Source* World Bank (2022); MOE of France (2010b), Ministry of Finance (2020); Ministry of Education and Training of Vietnam (2008), German Research Foundation (2005), MOE of ROK (2013), Ministry of Education and Science of the Russian Federation (2013), Academy of Finland (1995), Planning and Budget Committee of Israel (2011), Danish National Research Foundation (1991), Australian Research Council (2009), Xiong and Chen (2020), *Notes* 1. To calculate the proportion of total grant funding in the total GDP in the corresponding period, the periods covered in Fig. 6 is the same as that in Fig. 5. The total GDP of each country is calculated based on its GDP data in the following period: France 2012–2016, China 2016–2020, Vietnam 2011–2020, Germany 2007–2017, ROK 2013–2020, Russia 2013–2017, Finland 1995–2019, Israel 2011–2016, Denmark 1993–2020, Australia 2009–2020, and Japan 2014–2020. 2. The total GDP in the corresponding period are as follows: France US$13.25 trillion, China US$66.43 trillion, Vietnam US$2.05 trillion, Germany US$39.34 trillion, ROK US$12.45 trillion, Russia US$8.56 trillion, Finland US$5.24 trillion, Israel US$1.74 trillion, Denmark US$7.42 trillion, Australia US$16.12 trillion, and Japan US$34.52 trillion

US$34.52 trillion (World Bank, 2022), while the grant funding accounts for only 0.03‰, which is the lowest among the 11 countries.

2.7 *Funding for Excellence Initiatives Per Institution*

During the period of 2016 to 2020, the average funding for each university of the Double World-Class Project of China is about US$0.09 billion. The funding for excellence initiatives per institution in the other 10 countries is about US$0.15 billion (Fig. 7).

The funding for each institution in France and Germany are significantly higher than that in other countries. Each HEIs of France's IDEX receives about US$0.78 billion, and the amount is much higher than other countries. Each HEIs of Germany's Excellence Initiative receives about US$0.38 billion. The funding for each HEIs in Vietnam's New Model University Project is unexpectedly higher than that of most countries. It allocates about US$0.13 billion to each HEIs. The funding for each HEIs in Denmark, Australia, Russia, Finland, Japan, ROK, and Israel are between US$0.02 billion and US$0.06 billion.

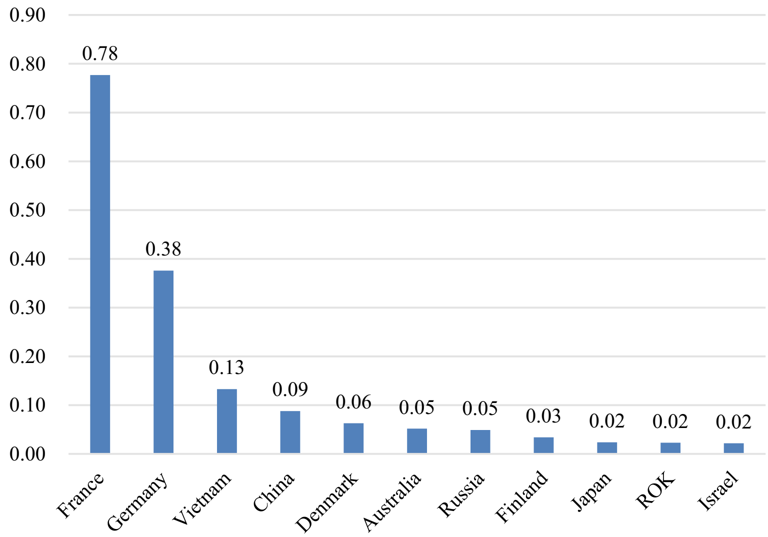

Fig. 7 Funding for excellence initiatives per institution (in US$ billion). *Source* MOE of France (2010a, 2010b), German Research Foundation (2005); Ministry of Education and Training of Vietnam (2008), MOE et al. (2017a), Ministry of Finance (2020), Danish National Research Foundation (1991), Australian Research Council (2009); Ministry of Education and Science of the Russian Federation (2013), Academy of Finland (1995), MEXT of Japan (2014a), Xiong and Chen (2020), MOE of ROK (2013), Planning and Budget Committee of Israel (2011). *Note* Funding for excellence initiatives per institution are calculated based on the data in Figs. 1 and 5

Based on the analysis above, it can be found that China ranks first in the number of funded HEIs, the duration, and the total funding amount, ranks second in the proportion of total funding in GDP, and ranks fourth in the funding for each institution. These results indicate that China has placed great emphasis and efforts on the Double World-Class Project. However, it cannot be ignored that, regarding the percentage of funded institutions in total HEIs, China ranks in the middle among the 11 countries, therefore, further investment on more HEIs may be needed for the future development.

3 Excellence Indicators

3.1 Design

This section evaluates excellence initiatives from three dimensions: goals, resources, and outcomes. "Goal" refers to the objectives of excellence initiatives, "resource" refers to the durations and funding amounts for excellence initiatives, and "outcome" refers to the achievements of excellence initiatives.

3.1.1 Goal

Excellence initiatives of many countries are generally proposed to provide the best working environment to attract top talents and conduct world-leading research, so as to improve international competitiveness. Ultimately, these initiatives will help these countries take their share and gain visibility and reputation in global competition. Different countries tend to set up different goals based on their own situation and demand. Based on the level of development, countries and their development of excellence initiatives can be divided into three categories. For countries with a strong higher education system, such as Germany, France, and Japan, the goal is to reinforce the existing international competitiveness and to continue to expand the advantages in global education market. For countries with a relatively developed higher education, such as China, ROK and Russia, the goal is to improve its capacity and visibility in global competition. For countries where higher education development is still far from making influence in global higher education market, such as Vietnam, Thailand, and African countries, the goal is to gain their international standing in the global stage by conducting international research. The goals of excellence initiatives reflect trends and dynamic status of higher education development in each country. Moreover, idealized world-class universities are global organizations by nature and belong to the whole world. World-class universities should hold a vision that extends their development beyond national boundaries, contribute to global common goods, embrace and respond to the challenges of human being, serve international community, and strive to make achievements that have far-reaching impacts on human civilization and social development (Van der Wende, 2009; Xu, 2013). To certain extent, many countries integrate their national strategies and global vision into their excellence initiatives, and at the same time advocate to solve global challenges by making innovative breakthroughs in scientific research and make contributions to global common goods and human well-being.

3.1.2 Resource

To attract high-quality HEIs to join excellence initiatives, many countries endeavor to provide strong financial support. It takes time to build world-class universities, particularly those universities that are capable of making national and international contributions. Since the 1990s, many countries have successively launched their excellence initiatives with the durations ranging from five to 35 years. Excellence initiatives require countries to integrate regional educational resources and need a long-term dynamic process to promote academic excellence and enhance the country's overall higher education strength (Li, 2005; Zhang & Liu, 2015). These reasons have led most countries to formulating long-term strategies and providing continuous funds to excellence initiatives for more than 10 years. Countries generally allocate block funding to a small number of selected institutions. Even though many factors affect the funding process, the financial support and resources provided by governments are always very attractive (Qiu & Ou, 2016).

3.1.3 Outcome

International standards are usually adopted to evaluate the outcomes of excellence initiatives. Global university rankings are the most direct approach to do so. Many countries also include specific goals in terms of their standing in global rankings in their strategic planning. The most common criterion of a strong global position is "entering the world top 100" which indicates "excellence". Universities' performance in global rankings is a key manifestation of the "outcome" of excellence initiatives. Some quantitative indicators of a university's strength, such as the number of research publications and the degree of internationalization, could raise a university's global ranking rapidly, but they cannot indicate whether a university has gained global reputation that matches its ranking. The recognition of peers could be used as an indicator of a university's intangible strength (Feng et al., 2022). Peer review is often employed by global rankings. It not only indicates that a university's achievements have been recognized by peer academics, but also implicitly shows a university's intangible resources, such as status, reputation, or level (Yan, 2007). The higher evaluation outcomes on peer review, the higher recognition a university has.

3.2 *Definitions and Sources*

This section compares China's Double World-Class Project and the excellence initiatives of 10 countries: Australia's ARC Centers of Excellence, Denmark's Centers of Excellence, Finland's Centers of Excellence, France's IDEX, Germany's Excellence Initiative, Israel's I-CORE, Japan's Top Global University Project, ROK's BK21 Plus, Russia's Project 5–100, and Vietnam's New Model University Project. In accordance with the design ideas, 10 indicators are selected (Table 1).

The "goal" dimension employs two indicators: "specific goals of excellence initiatives" and "concept of serving global common goods in excellence initiatives". The data are mainly from the official documents of excellence initiatives issued by governments. The evaluation results of "specific goals" include "sufficient" (++), "involved but not sufficient" (+), and "not involved" (-). "Sufficient" means that excellence initiatives have presented specific and quantitative development goals; "involved but not sufficient" means that excellence initiatives have mentioned the concepts of development goals at the macroscopic level; "not involved" means that excellence initiatives have not formulated any development goals. The evaluation results of "concept of global common goods" include "sufficient" (++), "involved but not sufficient" (+), and "not involved" (-). "Sufficient" means that excellence initiatives have explicitly put forward serving the common interests of global society and human being; "involved but not sufficient" means that excellence initiatives have put forward integrating in global communication, establishing a global cooperation network, or contributing to solving global problems; "not involved" means that excellence initiatives have not explicitly mentioned contribution to global development.

The "resource" dimension employs four indicators: "duration of excellence initiatives", "total funding amount for excellence initiatives", "total funding for excellence initiatives as a proportion of GDP", and "total funding for excellence initiatives as a percentage of government expenditure on higher education". The data of durations

Table 1 Evaluation indicators of excellence initiatives

Dimensions	Excellence indicators
Goal-1	Specific goals of excellence initiatives (++/±)
Goal-2	Concept of serving global common goods in excellence initiatives (++/±)
Resource-1	Duration of excellence initiatives (long term/medium term/short term)
Resource-2	Total funding amount for excellence initiatives
Resource-3	Total funding for excellence initiatives as a proportion of GDP
Resource-4	Total funding for excellence initiatives as a percentage of government expenditure on higher education
Outcome-1	Fluctuation ratio of the percentage of funded universities in world top 100
Outcome-2	Fluctuation ratio of the percentage of funded universities in world top 500
Outcome-3	Peer recognition: Standard value of the fluctuation of citation frequency by world top 100 universities

and grant funding are from the official documents published by governments,[1] the data of GDP are from World Bank (World Bank, 2022), and the data of government expenditure on higher education are from UNESCO Institute for Statistics (UIS, 2022).[2] The evaluation results of “duration of excellence initiatives” include “long term (L)”, “medium term (M)”, and “short term (S)”, which refer to “over 20 years”, “10–20 years” and “less than 10 years” respectively. The statistics of funding amounts are converted into US$ for comparison. The results of “total funding for excellence initiatives as a proportion of GDP” and “total funding for excellence initiatives as a percentage of government expenditure on higher education” use the data of the total GDP of the country and government’s total expenditure on higher education in the corresponding periods.

The “outcome” dimension employs three indicators: “fluctuation ratio of the percentage of funded universities in world top 100”, “fluctuation ratio of the percentage of funded universities in world top 500”, and “peer recognition: standard value of the fluctuation of citation frequency by world top 100 universities”. The original data of world university rankings are from ShanghaiRanking (Academic Ranking of World Universities [ARWU]), Times Higher Education (THE World University Rankings), and Quacquarelli Symonds (QS World University Rankings). The method is calculating the fluctuation ratio of the percentage of funded universities in world top 100 and world top 500 since the emergence of world university rankings in 2003 or 2004 (the entering to any one of the three rankings counts). The original data of “peer recognition” are from the official websites of world top 100 universities. The information released on universities’ official websites is usually authorized, public, and dynamic; it covers the stakeholders including students, faculty members, and administrative personnel, and covers contents such as scientific research, teaching, and school service (Feng et al., 2022). The method is calculating the increase of the average frequency of funded universities mentioned by world top 100 universities (excluding their domestic universities) on official websites from 2003, and the highest value is standardized as 1.00.

3.3 Findings

Table 2 presents evaluation results of the excellence initiatives in selected countries in different dimensions.

In terms of “specific goals”, countries with “sufficient” performance, namely, specific and quantitative goals include France, Japan, ROK, Russia, and Vietnam. Their excellence initiatives have clearly defined their targets of international positions. France’s IDEX aims to construct five to 10 world top universities that are

[1] For some countries, the data of funding in some periods are unavailable, so the average numbers of the periods around are calculated as estimation.

[2] For some countries, the data of government expenditure on higher education in some periods are unavailable, so the average numbers of the periods around are calculated as estimation.

Table 2 Evaluation results of the excellence initiatives of the 11 selected countries

Countries	Specific goals	Concept of global common goods	Duration	Total funding amount (in US$ billion)	Total funding in GDP (‰)	Total funding in HE expenditure (%)	Fluctuation ratio of world top 100 (%)	Fluctuation ratio of world top 500 (%)	Peer recognition
Australia	+	+	M	0.78	0.05	0.38	−20.00	20.00	1.00
China	+	+ +	L	13.00	0.20	1.45	3.40	36.74	0.18
Denmark	+	+	L	0.44	0.06	0.26	14.29	0.00	0.84
Finland	+	–	L	0.48	0.09	0.48	0.00	7.14	0.28
France	+ +	–	M	8.55	0.65	5.25	18.18	63.64	0.21
Germany	+	+	M	5.26	0.13	1.06	7.14	7.14	0.76
Israel	+	+	S	0.13	0.07	0.82	33.33	0.00	0.70
Japan	++	++	M	0.89	0.03	0.65	2.70	−10.81	0.25
ROK	++	–	S	1.46	0.12	1.34	7.81	9.38	0.04
Russia	++	+	S	1.02	0.12	1.48	0.00	57.14	0.05
Vietnam	++	–	M	0.40	0.20	2.41	0.00	0.00	0.05

Notes "L" refers to "long term" (over 20 years), "M" refers to "medium term" (10–20 years), and "S" refers to "short term" (less than 10 years) competitive globally and improve the international competitiveness and reputation of French higher education and research departments (MOE of France, 2010b). The goal of Russia's Project 5–100, as the name points out, is to build five universities that are able to enter the world top 100 (Ministry of Education and Science of the Russian Federation, 2013). The goal of Vietnam's New Model University Project is to have three universities enter into world top 200 by 2020 (Ministry of Education & Training of Vietnam, 2008). The goals of Japan and ROK's excellence initiatives are more detailed. Japan's Top Global University Project sets specific goals for each participating university, including goals related to internationalization, governance, and education reform, and evaluates the implementation of these goals through various indicators (MEXT of Japan, 2014a). ROK's BK21 Plus puts forward to construct a number of world-class research universities in the top 100 of QS, it also stipulates the number of outstanding research talents to be produced in academic fields and new industries every year, and requires universities to raise the citation frequency of ROK's SCI papers (MOE of ROK, 2013). Although other countries' excellence initiatives have not put forward quantitative goals, they have outlined their development goals on a macro level. China's Double World-Class Project puts forward the goal of supporting a few high-quality universities and disciplines to become world-class, gradually making China a powerful country in higher education (the State Council, 2015). Denmark regards its Centers of Excellence as "the incubator of future top researchers" and seeks to create an energetic, creative, and international research environment for them (Danish National Research Foundation, 1991). Germany's Excellence Initiative aims to promote scientific and technological research in German universities, enhance their international competitiveness, and train more young scientists; it also increases the funding for outstanding universities, outstanding young researchers, collaborative projects between different universities, and international cooperation (German Research Foundation, 2005). There is hardly any excellence initiative that has not set development goals.

In terms of "concept of global common goods", excellence initiatives generally emphasize national development, while most of them do not directly mention global benefits. Only China and Japan's excellence initiatives involve the concept of serving the global common goods. China's Double World-Class Project requires universities to undertake scientific research tasks concerning human survival and development, provide world-class innovation platforms for talents, respond to global challenges, and defend human well-being (MOE et al., 2022b). Japan's Top Global University Project clearly states that its mission is to train talents who have global thinking and tolerance of different cultures, and who are able to make contributions to solving global problems, play a leading role in international community, and be willing to work for social welfare (MEXT of Japan, 2014a). However, it cannot be ignored that the idea of solving global problems through international cooperation has been followed by many countries. Australia's ARC Centers of Excellence explicitly seeks to develop collaboration with leading countries and their international academic centers or research projects, so as to build an extensive global network (Australian Research Council, 2009). Germany's Excellence Initiative emphasizes strengthening the cooperation between German universities and international academic institutions

(German Research Foundation, 2005). Israel's I-CORE puts forward to cooperate with world-leading research institutions and scholars (Planning & Budget Committee of Israel, 2011). In terms of "resources", China, Denmark, and Finland's excellence initiatives have long durations (more than 20 years); medium length duration for Australia, France, Germany, Japan, and Vietnam's excellence initiatives (10–20 years); and relatively short duration for Israel, ROK, and Russia's excellence initiatives (less than 10 years). In terms of "total funding amount for excellence initiatives", up to now, the largest investment is witnessed in China's Double World-Class Project, which has reached US$13 billion (Ministry of Finance, 2020). The funding amounts for France, Germany, ROK, and Russia's excellence initiatives are also at a high-level exceeding US$1 billion. The funding amounts for Japan and Australia's excellence initiatives are between US$700 million and US$900 million. The funding amounts for Finland, Denmark, and Vietnam's excellence initiatives are around US$400 million. The funding for Israel's I-CORE is the lowest, which is only about US$130 million (Planning & Budget Committee of Israel, 2011). In terms of "total funding for excellence initiatives as a proportion of total GDP", France has the highest figure of 0.65‰. China, Vietnam, Germany, ROK, and Russia have relatively high proportions (over 0.10‰). The figures for other countries are below 0.10‰, and Japan has the lowest proportion (0.03‰). In terms of "total funding for excellence initiatives as a percentage of government expenditure on higher education," figure larger than 1% equates to a large investment. The figures for France, Vietnam, Russia, China, ROK, and Germany are higher than 1%. The figure for Vietnam is 2.41%, second only to France (5.25%). Denmark has the lowest percentage, which is only 0.26%.

In terms of "outcomes", most of the funded universities in various countries have enhanced their world ranking standings during the periods of their excellence initiatives. However, the performance of different universities in world rankings has varied. Specifically, universities funded by France's IDEX have made the greatest improvement, as the percentages of world top 100 and world top 500 universities have increased by around 20 and 60% respectively. This achievement may come from France's large investments and the integration of higher education resources, such as university merger. Countries with a big increase in the percentages of world top 100 universities include Israel and Denmark, with an increase rate of nearly 35% and 15% respectively. However, the percentages of world top 500 universities in these two countries have not risen. This example shows that the two countries' universities that have made remarkable achievements during the period of excellence initiatives are still domestic elite universities. China's percentage of funded universities in world top 500 has risen greatly, with an increase rate of nearly 37%, while the percentage of top 100 universities has increased slightly. This example shows that China's excellence initiatives has made significant achievements in the scale of world-class universities, while efforts are demanded for quality improvement. In ROK and Germany, the percentages of funded universities in world top 100 and world top 500 have increased slightly, with the increase rates of around 8%. This example demonstrates that the world rankings of funded universities have generally improved in these two countries. In Russia and Finland, the performance of the previous "disadvantaged" universities has been improved during the periods of excellence initiatives. In Russia, no funded university has entered world top 100,[3] while the percentage of world top 500 has increased by 57%. In Finland, the percentage of funded universities in world top 100 has not changed, while the figure for world top 500 has increased by 7%. Among the 11 countries, only Australia and Japan have showed negative growth, as Australia's percentage of world top 100 has dropped by 20% and Japan's percentage of world top 500 universities has dropped by about 10%. However, this change does not mean their disappointing performance in higher education; to the contrary, it is connected with their solid foundation for higher education. Australia and Japan had a number of world top 500 or world top 100 universities in previous time, due to increasingly fierce global competition in recently years, the performance of some universities has been unstable, thus resulting the negative growth. Furthermore, Vietnam's funded universities have not entered world top 500, which indicates that its excellence initiatives may have not made effective results yet.

In terms of "peer recognition", the universities funded by Australia's ARC Centers of Excellence have made the largest improvement, and they have been widely recognized by many world-class universities. Universities funded by Denmark's Centers of Excellence, Germany's Excellence Initiative, and Israel's I-CORE have enhanced their indices of "peer recognition" by more than 0.70. Universities funded by Finland, Japan, France, and China's excellence initiatives have made some progress, and their indices have increased by around 0.2. However, universities funded by Russia, Vietnam, and ROK's excellence initiatives have only raised their indices by less than 0.10, and most of these universities have not exerted an impressive influence in the world.

3.4 Discussion

China's Double World-Class Project has not stipulated specific or quantitative targets but put forth long-term development goals of developing academic excellence so as to help China become a strong higher education power. Different from Russia and Vietnam, China does not strive to make funded universities enter world top 100 or 200 within a period. Different from Japan and ROK, China has not employed specific performance indicators such as the number of innovative talents training projects, the citation frequency of academic papers, or the number of international faculty members and students. On the contrary, Chinese government encourages funded universities to build world-class universities with Chinese characteristics on their own foundations, and guarantees universities' decision-making powers (Zhang

[3] Russia's Project 5–100 has not funded universities with the best comprehensive strength, such as Moscow State University, as these universities have already received independent government funds.

et al., 2019). In the second round of the Double World-Class Project, Chinese government was determined to give funded universities more autonomy. The second round does not distinguish world-class universities and universities that are designated to develop world-class disciplines, while it requires universities to prioritize innovative breakthroughs (MOE et al., 2022a). Tsinghua University and Peking University, two of the most prominent universities in China and also as the pilot institutions in this project, are being provided autonomy to manage and design their own world-class discipline construction (*ibid*). In nature, excellence initiatives have national attributes, as the goals, the financial support provided and the selection process are closely connected with the governments' decisions, so serving national interests is generally an important premise for these initiatives. The Double World-Class Project is different from the excellence initiatives of most countries, as it specifically points out to serve global common goods. The Double World-Class Project states that Chinese world-class universities should be able to solve the common issues in human development, respond to global challenges, and promote human well-being (MOE et al., 2022b).

China's Double World-Class Project include a long-term funding period (over 30 years) and includes five-year cycles, while only a few other countries such as Denmark and Finland have planned to concentrate on long-term projects. During the period of the first round of the Double World-Class Project, China allocated more than US$13 billion in special funds to this project, which accounts for 0.20‰ of China's GDP and 1.45% of government expenditure on higher education in the corresponding period, and the funding amount is larger than those in most countries. To support the deep development of higher education, China's government expenditure on education has been steadily rising in recent years (Ministry of Finance, 2020). Chinese government has allocated special funds for building world-class universities and disciplines. At the same time, it has improved the budget system for local universities' characteristic development (*ibid*). Therefore, China's Double World-Class Project reflects its features of long funding duration, strong financial support, and diversified development.

As for the outcomes of the Double World-Class Project, funded universities have improved their global rankings, and have obtained some level of international recognition. In ARWU, THE, and QS, seven Chinese Double World-Class universities have entered world top 100 and 63 have entered world top 500, with an increase rate of 3 and 37% respectively in 2022. Chinese Double World-Class universities have expanded in scale in the early stages of the project. For example, the number of international papers, the ratio of international faculty members and students, and some other internationally recognized indicators have increased significantly, which lead to an increase in global university rankings. However, these funded universities are still relatively under-recognized in the world, with only 0.18 peer recognition value, which is considerably less compared to universities in Australia, Germany, and Israel. The same can be said to China's less satisfying performance in top grade indicators, such as the number of Nobel Prize and original research breakthroughs (Feng & Liu, 2021). The quality of Chinese top universities still needs further improvement. For the Double World-Class universities that have made significant progress in terms of quantitative indicators, it will still take time for them to improve their soft power that matches their corresponding world-class standards (Feng et al., 2022).

4 Best Practices

4.1 Sustainable National Strategies

4.1.1 National Strategic Significance

Many countries all over the world use excellence initiatives as national strategies because of their shared goals to enhance international competitiveness. These countries and universities try to adapt to the unprecedented changes of the world through the process of pursuing excellence. These national governments endeavor to provide optimal working conditions, recruit talented workforce, conduct leading research, and develop world-class universities and disciplines, as a means to increase soft power and enhance their competitiveness in global competition. Emerging information technology (IT), artificial intelligence (AI), and the digital economy have created new industries; and a new round of scientific and technological revolution and industrial transformation is reshaping the patterns of global innovation and profoundly changing the nature of work. This raises the demand to optimize industrial structures and promote infrastructure building for new technological advancement (Liu et al., 2021). Excellence initiatives can effectively coordinate and integrate a nation's higher education resources, strengthen financial support in specific institutions and fields, accelerate the technology breakthrough, and explore new development path.

As a national strategy, excellence initiatives focus on developing future skilled workforce and enhancing the strength of scientific research (Liu & Zhang, 2016), to guide high-quality development for the future. For example, ROK's BK21 Plus aims to develop world-class graduate schools and train a highly skilled workforce for Korea's socio-economic development (MOE of ROK, 2013); and Japan's 21st Century Center of Excellence (COE) Program aims to train world leading high-tech talents in Japanese universities (Zhao & Jiang, 2013). Most excellence initiatives also recognize the importance of research in meeting the needs of the nation and actively respond to the actual demands of economic, social, technological, and cultural development. For example, Australian's ARC Centers of Excellence plans to take climate, biology, quantum computing, and other aspects of national priorities as its project's preferred research fields (Australian Research Council, 2009). As a national-level strategy, excellence initiatives originate from local realities, rely on the countries' resources, and serve the countries' demands.

4.1.2 Universities' Responsibilities to Build World-Class Universities

In the future, top universities in each country will focus on talent training and scientific research, continue their investment in building world-class universities, and practice their commitment to solving national and global problems. Universities that aspire to become world-class usually define their responsibilities "based on local needs and engaged with the world". China's Tsinghua University explicitly proposes to build a comprehensive, research-oriented, and open leading university, with "global visions, world-class standards, Chinese characteristics, and Tsinghua style", which, in other words, aims to integrate international standards, national responsibilities, and institutional differences while developing academic excellence (Xiao & Jiang, 2015). University College London (UCL) in the U.K. takes "London's global university" as the central development goal, and it aims to create a diverse intellectual community with an outstanding ability to integrate education, research, innovation, and enterprise for the long-term benefit of humanity, so as to better understand the world, create and share knowledge, and solve global problems (UCL, 2015). The school motto of Princeton University in the U.S. states that a university is "a vibrant community of scholarship and learning that stands in the nation's service and the service of humanity".[4]

Specifically, world-class universities should be committed to taking responsibility for social development, understanding major needs of human development, conducting breakthrough research, training world leaders for global governance, providing innovative solutions to social problems, and ultimately exerting its "world-class" influence to promote development of the world and progress of human being.

4.1.3 Sustainable and Continuous Financial Support

Building world-class universities is time consuming. The common features of excellence initiatives in various countries include long project durations and abundant financial support. Funding cycles usually range from 5–12 years with quite a few countries choosing a long-term funding cycle of 10 years or more. China carried out Project 985 in three phases during the period from 1998 to 2015 and supported the project with special long-term funds from Chinese central government (MOE, 1998). Following Project 985, China launched the first round of the Double World-Class Project in 2017 (MOE et al., 2017a); after the first five-year round, seven universities were added in the second round in 2022 (MOE et al., 2022a). German launched the first round of Excellence Initiative in 2006, and its federal government and state governments jointly funded the first round from 2007 to 2012; the second round started from 2011 and the funding period was from 2012 to 2017 (German Research Foundation, 2005).

[4] https://www.princeton.edu/meet-princeton.

Strong financial support is needed to successfully implement excellence initiatives. A single institution in Japan's Top Global University Project receives US$20 million (MEXT of Japan, 2014a); a single institution in Australia's ARC Centers of Excellence receives US$50 million (Australian Research Council, 2009); and a single institution in Germany's Excellence Initiative receives US$380 million (German Research Foundation, 2005). These financial investments have led to rewarding outcomes. One direct outcome is that funded universities' research productivity has been effectively improved, as the number of papers published on top journals, the number of patents, and the level of industry-university-research cooperation have significantly increased (De Filippo et al., 2016; Lehmann & Stockinger, 2019). With continuous funding support, selected universities can improve overall capacity, and gradually enhance their positions in global rankings and gain prestige in the global higher education market (Menter et al., 2018).

4.2 Strategic Planning Leading Excellent Development

At the institutional level, strategic planning is the process of making long-term goals and putting those goals into practice. Effective strategic planning contributes to universities' development. As international competition in higher education is intensifying, an increasing number of leading universities have formulated strategic plans to develop academic excellence. In nature, strategic planning typically sets long-term goals, designs comprehensive planning, translating the overall goals into step actions, and provides directional guidance for universities.

4.2.1 Long-Term Goals

Building world-class universities is regarded as a long-term vision which requires a lengthy process. Universities should propose more ambitious goals and targets than their current development. The timeline to achieve the goals should be set for 5–10 years or even longer; it requires long-term, dedicated efforts to work towards these goals.

For example, Shanghai Jiao Tong University (SJTU) includes in its strategic plan: to develop academic discipline clusters with world-class influence, to provide excellent faculty and students for other world-class universities, to attract global talents and build a global talent community; to make contributions to the country and the world, and to become an attractive destination for students around the world (Lin, 2021). Following the guidance of strategic plan, SJTU has adhered to the goal of pursuing excellence and improving the comprehensive strength of the university through long-term and continuous endeavor. Since 1996, SJTU invested in strategic planning to build a world-class university based on a 10-year cycle. In the process of laying a strong development foundation and gradually forming superiority, SJTU formulates the aim of building a world-class university in 2050 (Lin, 2021).

4.2.2 Comprehensive Planning

It is through comprehensive planning that institutions can seek to improve the quality of talent training, faculty, disciplines, scientific research, and internationalization to reach world-class standards, integrate the university's vision and goal into the work and study of faculty members and students so as to gain full recognition, and focus on the comprehensive development of the university.

University of California Riverside (UCR) is a case that successfully combines the vision of university with the development of faculty members and students. The university is committed to effectively serving students of low-income and under-represented ethnic minority groups, helping them complete their studies, and, at the same time, maintaining a high level of research productivity and excellence (Lin, 2021). Faced with the public pressure and the decline of confidence brought by global ranking, UCR immediately focuses on the implementation of its strategic plan "UCR 2020: The Path to Preeminence". This strategic plan elaborates a series of measures to pursue excellence, by improving academic level, increasing the enrollment opportunities and the diversity of students, and promoting the participation at local, national, and global levels (UCR, 2010). The key points of the strategic plan include developing outstanding faculty, paying attention to the statement and training of diversity to ensure the representation of female and minority faculty, forming a multicultural communication environment, helping students from low-income and minority backgrounds to improve academic performance, appointing a task force of UCR's Graduation Rate Initiative to improve graduation rates, and effectively promoting social mobility in the country (UCR, 2010). It can be found that the whole university has initiated a strong dialogue among stakeholders, which closely links the excellent development plan of the university with the personal development of its members, thus gaining wide recognition and support.

4.2.3 Step-by-Step Action Plans

The design and implementation of strategic planning needs to be divided into several specific plans in different development stages based on each university's features and demands. University leadership or external consultants usually play the role of overall implementing and coordinating the strategic planning process.

SJTU's "Three-Step" strategy for developing world-class university provides a good example. The first step covered the period from 1996 to 2010, during which the main task of SJTU was to restructure the university's organization, with the aim of building a comprehensive, research-oriented university with a high level of internationalization, thereby laying a solid foundation for building a world-class university (Lin, 2021). The second step covered the period from 2011 to 2020, during which the main task of SJTU was to make academic breakthroughs and further develop the advantages of the university, with the aim of reaching world-class status and entering (or getting close to) the world's top 100 list (*ibid*). The third step covers the period from 2021 to 2050, during which the main task of SJTU is to improve

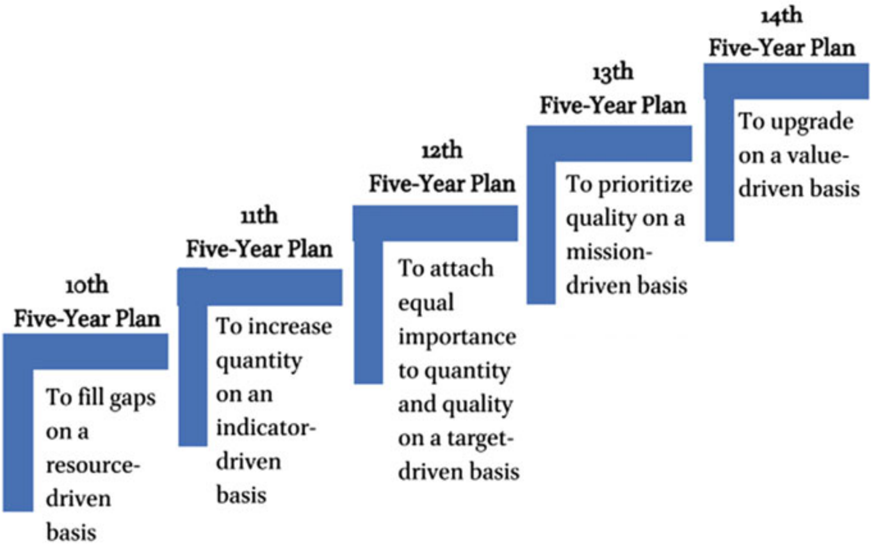

Fig. 8 Focuses of STJU's strategic plans in the past 20 years. *Source* Lin (2021)

the comprehensive strength, with the aim of fully realizing its goal to become a world-class university (*ibid*).

The third step has been divided into two stages. SJTU aims to reach the top echelon of global universities from 2021 to 2035, and then to become a world top university during the period between 2035 and 2050, in terms of the outcomes of talent training, the quality of scientific research, the governance system and the operational model, as well as the educational ideas, eventually becoming an academic palace gathering great masters (*ibid*) (Fig. 8).

4.2.4 Directional Guidance

The current world is ever-changing, such as the global economic downturns, the ongoing pandemic, and the slowdown of international collaboration; however, the trend of building academic excellence is likely to remain unchanged. University leadership should take on a forward-looking planning.

Within its 14th Five-Year Plan, SJTU is working "to comprehensively improve the overall strength of the university and to achieve world class status". This plan aims to strengthen the university through talent recruitment and development, promote innovation through interdisciplinary cooperation and consolidate basic research, emphasize on developing international collaboration and global communities, and further consolidate an excellence culture within the university (Lin, 2021).

In addition, UCR's case also shows its emphasis on cutting-edge science and technology. Its future-oriented excellent development strategy specifically points out promoting teacher cooperation in interdisciplinary and emerging academic fields and employing scholars from innovative groups such as transformational science and intelligent systems (UCR, 2010).

5 Inspiring Stories

5.1 Guo Xinli: Devoting in Cross-Century Education Projects

5.1.1 An Administrator of China's World-Class University Development

Directly Involving in the Design and Management of Project 211 and Project 985. Guo Xinli is the leader of Shandong University (SDU) of China (SDU, 2017). He has served as the director of the Department of Degree Management and Graduate Education of MOE, the office director of the Inter-Ministerial Coordination Group of Project 211, and the office director of Project 985 (*ibid*). Guo has been engaged in higher education management in MOE and its affiliated agencies for years and has gained abundant practical experience. At the end of the last century, how to train high-quality talents and conduct high-level scientific research has become an important question in China (MOE, 1998). With this background, Chinese government initiated two cross-century higher education projects: Project 211 and Project 985. Guo has been continuously involved in the construction of these projects since he was an officer of MOE (Guo, 2021). Looking back upon the initiation of China's world-class university construction efforts in the 1990s, Guo stated that the consensus of Project 211 and Project 985, at the very beginning, was to serve the development of the country; thus, they have set the goals of training high-quality talents and solving important problems for economic and social development (*ibid*). In order to realize the goals, he and a group of specialists devoted themselves to the planning and evaluation, working day and night (*ibid*). After years of hard work on Project 211 and Project 985, China's world-class university construction has grown from scratch. Guo successively presided over the compilation of *Project 211 Development Report* and *Project 985 Construction Report*, which systematically summarized the achievements and experience of China's world-class university building efforts and made predictions for the future (Office of the Inter-Ministerial Coordination Group of Project 211, 2007; the Compilation and Research Group of *Project 985 Construction Report*, 2011). Guo expects these projects could contribute Chinese solutions and wisdom to the development of higher education around the world.

Actively Promoting the Implementation of the 2011 Plan. When Project 211 and Project 985 have made some successful results, Guo was committed to maintaining the achievements and he participated in the 2011 Plan, which aims to comprehensively enhance the innovation ability of Chinese universities (Yuan & Guo, 2012). The core of the 2011 Plan is to improve the innovation abilities of talents, disciplines, and scientific research by building national-level and university-led collaborative innovation centers (MOE & Ministry of Finance, 2014). Guo, as the principal person in charge of the 2011 Plan, has participated in an online forum with several MOE colleagues and answered questions about how to improve the quality of Chinese higher education (Ke & Wan, 2012). He introduced and emphasized MOE's future reform on talent training, which included enhancing students' comprehensive quality and innovation ability, strengthening the combination of talent training with industries and enterprises, improving the tutor system featured with scientific research and practical innovation, and strengthening the reform of teaching and the management of learning (Ke & Wan, 2012). The 2011 Plan is not as far-reaching as Project 211 and Project 985 because it is smaller in scale, shorter in duration, and does not directly target the development of world-class universities. However, the improvement of universities' innovation ability brought by the 2011 Plan has laid a foundation for the subsequent Double World-Class Project.

5.1.2 A Researcher of China's World-Class University Development

Long-Term Investigation in the Evaluation of Higher Education. In order to ensure the efficiency of world-class university and discipline development, Guo carried out evaluation studies as a professional researcher while working in MOE. He sought to establish a reasonable and feasible evaluation system; he published several academic papers and books such as *Research on the Selection Methods of Key Disciplines in Universities* and *The Road to China's Leading Universities: From Project 211 to the 2011 Plan* (Guo, 2002; Yuan & Guo, 2012). Guo proposed that the key to performance evaluation is rule, which should guide the evaluation direction, embody the idea of diversified evaluation and combine qualitative and quantitative methods (Guo, 2011). As for the evaluation of world-class universities, Guo (2004a) designed a general model of university funding based on evaluation results and applied it to the allocation of government's special funds of Project 211. The model insisted on the principle of fairness and competition and applied scientific evidence to funding of key development projects. As for the evaluation of world-class disciplines, Guo (2002) designed an evaluation index for universities' key disciplines; this system includes several aspects, such as the number of faculty members with senior professional titles, graduate students in school, master's and doctoral degrees awarded, papers published on foreign journals, over-provincial level awards, research projects, and research funds. These measures help verify the objectivity of experts' evaluation. Guo (2003a) also established an evaluation model for discipline effectiveness through Data Envelopment Analysis (DEA) method, which analyzes the input and output of the same discipline in different universities; the evaluation results are conducive to the development of disciplines.

Long-Term Investigation in the Reform of Graduate Education. Guo emphasizes the development of graduate education in world-class universities and conducted research on the quality improvement of graduate education. During his time working in MOE, Guo regularly made suggestions to a core Chinese journal of graduate education named *Academic Degree and Graduate Education*. By learning from his practical work experience, he provided solutions for the problems of graduate education (Guo, 2004b; Zhou, 2012). Guo proposed that the establishment of graduate school system must be considered in the development of leading universities and key disciplines (Guo, 2003b). He argued that the functions of graduate school should be optimized, the approval and establishment of graduate school should be standardized, the global competitiveness of Chinese graduate education should be enhanced, and the organization and management team of graduate school should be strengthened. He proposed that graduate school should become a base for training high-quality innovative talents and solving important scientific and technological problems, and a model for the development of world-class universities and disciplines (*ibid*).

5.2 Zhang Jie: A Man of Action in World-Class University Development

5.2.1 A World-Class University President as Well as an Educator

Keeping Close Relationship with Students. Zhang Jie is a world-famous physicist, he was elected as an Academician of Chinese Academy of Sciences (CAS) in 2003, and elected as a Foreign Associate of National Academy of Sciences (NAS) of the U.S. in 2012, and he is the President of Chinese Physical Society (SJTU, 2022a). Zhang was appointed as the President of SJTU from 2006 to 2017, and currently in SJTU, he is a professor of the School of Physics and Astronomy, the Director of Academic Committee, the Honorary Dean of Zhiyuan College, and the Director of Tsung-Dao Lee Institute (SJTU, 2022a). As the president of SJTU, in addition to routine management work, he took pleasure in spending time with students. From the first month of taking office as the president, Zhang often posted on SJTU's BBS and communicated with students online (SJTU, 2010a). Since then, more and more students have affectionately called him "Jie Ge", which means "Brother Jie". He is delighted in this name and thinks it represents students' commendation and expectation (*ibid*). Zhang believed that listening to students' voices is significant for a university president, so every day he tried to spare time to get to know students' thoughts through the Internet (SJTU, 2007a). For example, he has directly responded to a post about the quality problem of desks and chairs in a teaching building, he appreciated these suggestions and put forward his wish of making SJTU a university full of love (SJTU, 2007a). Zhang was willing to get involved in the classroom and participate in campus activities with students. He once delivered a lecture on the theme of "Our Dream", which aimed to guide students to better understand the country and form student ideals; in the lecture, he patiently answered students' questions and enjoyed close communication with them (Chen & Du, 2014). He also served as the leading runner in the "U-Run 2015 SJTU Campus Marathon", which fulfilled the promise he made to students one year ago–serving as the leading runner again in the next U-Run Marathon (SJTU, 2015). The students of SJTU commonly agreed that Zhang is a president with great personal charisma.

Advocating for the Concept of "Educating". At the commencement and graduation ceremonies of SJTU, Zhang has repeated that the fundamental goal of a university is to educate individuals (*peiyang ren*) (SJTU,). SJTU is committed to training world-class leaders, and the concept of "educating" that Zhang has emphasized not only requires students to learn professional knowledge and skills in SJTU, but also demands them to develop morality and independent personalities (SJTU, 2013). More precisely, the concept of "educating" means that universities should educate well-rounded individuals with empathy, patriotism, sincerity, kindness, and virtue (SJTU, 2007a). For example, SJTU has established a hospice care association, through which students visit nursing homes and serve elderly adults without children to care for them (Sun, 2009). These ideas are in accord with the motto of SJTU, "When you drink from the stream, remember the spring. Love your country and add credit to your alma mater (*Yinshui Siyuan, Aiguo Rongxiao*)". This motto represents the spirit of SJTU and it has been leading the university's development. Although SJTU has a historic advantage in science and engineering, Zhang has never relaxed the requirements for developing liberal arts in his term of office, which has been conducive to strengthening the humanistic atmosphere of the university (SJTU, 2007a). Moreover, Zhang has designed a distinct orientation for humanities and social sciences of SJTU that differs slight from traditional liberal arts programs. His program places greater emphasis on the analysis of Chinese culture and images from distinctive perspectives (Sun, 2009).

5.2.2 A Reformer of World-Class University Development

Emphasizing the Reform of Innovative Talent Training. Zhang believes that the key point of building a world-class university is talent development. As president, he insisted on guiding the university to explore and practice an education system to foster top innovative talents. He encouraged faculty to have wide discussions on this topic, which finally determined that the idea of talent training in SJTU should be the trinity of "imparting knowledge", "constructing ability", and "cultivating personality"; the goal of talent training should to produce elite talents with innovative spirit and leadership in different fields for the new era (SJTU, 2009). In order to realize this goal, Zhang initiated a systematic reform of syllabus, curriculum systems, teaching, and practical activities in SJTU. Since 2009, SJTU has started to implement a new training model for top innovative talents, which could be summarized as "one center and three combinations" (Zhang & Wang, 2012). "One center" means student-centered and "three combinations" refers to the combination of class and after-class, teaching and research, and scientific literacy and humanistic spirit. Zhang pointed out that the new model would bring two major changes. First, the method of imparting knowledge would be changed as the application of new technologies made online courses possible. Second, the orientation of ability cultivation would be changed, as the ability of discovering problems, raising questions, solving problems, integrating knowledge, and effectively communicating would be emphasized in the future (SJTU, 2010b). Generally speaking, the talent training reform initiated by Zhang aims to help students experience the spiritual pleasure of exploring the unknown and pursuing truth, rather than restricting them in skill acquisition (SJTU, 2009).

Emphasizing the International Influence of SJTU. World-class universities must have strong international influence, so Zhang made efforts to speed up the internationalization of SJTU and worked to realize a "comprehensive, innovative, and international" vision (SJTU, 2022b). He modestly stated that he had been learning from the presidents of foreign world-class universities and had communicated with 45 university presidents from different countries (International Affairs Division of SJTU, 2008). In order to understand the experience of other world-class universities comprehensively, Zhang led a visiting team and went to many universities, including Technical University of Munich and University of Munich in Germany, Group of Eight (Go8) in Australia,[5] and the University of California in the U.S. (SJTU,). These visits help SJTU establish cooperation agreements with many world-top universities and expand its international affairs. Based on the experience, Zhang not only paid attention to the internationalization of student enrollments, but also worked to promote the internationalization of faculty and administrators. SJTU attaches importance to recruiting global talents and developing overseas training and is committed to training international teams with vision (International Affairs Division of SJTU, 2008). These measures have had some positive effects. In 2016, SJTU entered the world top 100 for the first time (QS, 2016). Since then, its global ranking has been continuously rising and its international influence has continued to increase.

Building a High-Quality Teaching Team. Zhang believes that high-quality teaching staff is the key to building a world-class research university. SJTU insists on recruiting and training outstanding talents. At the same time, it has formulated flexible and systematic evaluation criteria as encouragement (Sun, 2009). Zhang presided and published a "three-step strategy" of SJTU, which includes "recruiting and mentoring junior staff", "three career tracks for faculty", and "one merged tenure system". The first step "recruiting and mentoring junior faculty" means that SJTU will recruit excellent young scholars worldwide, strengthen teacher training, and launch a pilot tenure-track system to provide more opportunities for junior staff (Zhang, 2014). The second step "three career tracks for faculty" designs three development routes for faculty, which are teaching-oriented, research-oriented, and research-teaching-parallel. This approach guarantees the school's decision-making powers of recruiting, training, and evaluating faculty members (*ibid*). The third step "one merged tenure system" provides a system for overseas talents and local talents to "compete on one stage and improve together". SJTU seeks to build a faculty system that includes both

[5] Group of Eight (Go8) of Australia includes eight Australian leading universities: Australian National University, The University of Adelaide, The University of Melbourne, Monash University, The University of New South Wales, The University of Queensland, The University of Sydney, and The University of Western Australia.

tenure and contract systems, which works to create a fair, open, and competitive environment (*ibid*). Some world-class university presidents and well-known educators have expressed their agreement for faculty management reforms at SJTU, by stating that Chinese university leaders need to face the challenges of building world-class universities by making plans to overcome current difficulties (Cao & Yan, 2014).

6 Latest Research

6.1 General Overview

This section reviews the academic research on excellence initiatives during the past decade. Excellence initiatives are an important theme of educational research both in China and in the world. The Double World-Class Project has become a research focus in China since its promulgation in 2015; in the world, scholars mainly focus on the outcomes of excellence initiatives, the mobility of scientific research talents generated by excellence initiatives, and their impacts on national education system.

6.1.1 Latest Research in China

To investigate the latest research of excellence initiatives in China, “world-class universities” and “education” are searched as keywords in the China National Knowledge Infrastructure (CNKI) database. The proportion of academic articles on “world-class universities” over the total number of research articles in education from 2012 to 2021 is calculated (see Fig. 9). During the 10-year period, over 3,400 articles related to “world-class universities” were published, accounting for about 0.20% of total research articles in education and about 1.57% of research articles in higher education. These data indicate that the development of world-class universities have received constant attention in China. The proportion of studies on world-class universities has experienced a period of rising and then tended to be stable. The rise is closely connected with the time when the Double World-Class Project was issued. As mentioned in Sect. 1.3 of this chapter, China promulgated *The Overall Plan for Promoting the Construction of World-Class Universities and World-Class Disciplines* (the first policy document of the Double World-Class Project) in the end of 2015, and then the proportion of studies on world-class universities began to increase to 0.22% in 2016. In 2017, the issue of the implementation measures and the university list of the Double World-Class Project marked the official start of the first round of this project, which led to the outbreak of “world-class universities” related studies. The proportion rose rapidly and peaked at 0.31% in 2018. After 2019, with the stable progress of the Double World-Class Project, the proportion of studies on world-class universities gradually returned to normal. The figures were around 0.16% in 2020

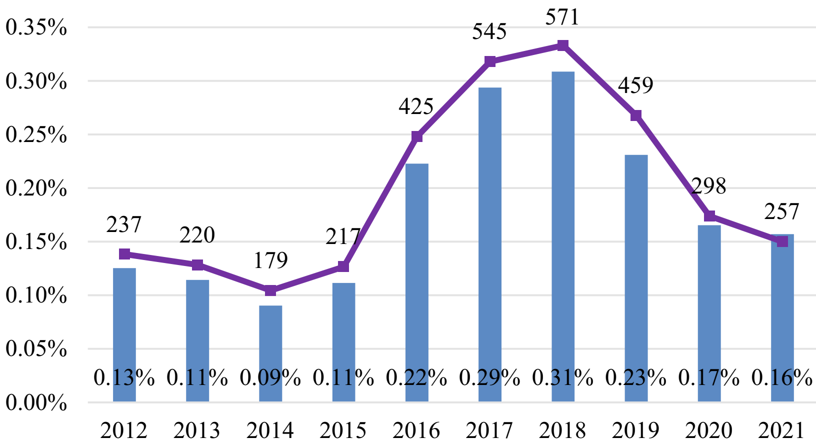

Fig. 9 Number and proportion of articles on "world-class universities" over total articles in education research in China (2012–2021). *Source* Compiled from search results from CNKI

and 2021, but still higher than the figures before the promulgation of the Double World-Class Project.

During the past 10 years, most research on world-class universities focused on the strategies of the Double World-Class Project, while others focused on strategies for building world-class universities and disciplines. It is evident that Chinese scholars have attached importance to this research topic with China's constant promulgations of national strategies on improving the comprehensive strength and international competitiveness of higher education.

Research Embedded in Chinese Context. The existing research suggests that building world-class universities should be discussed in the Chinese context and serve decision-making and implementation of policies. Bai (2018) analyzes the logic of developing Double World-Class universities with "Chinese characteristics", and proposes paths to academic excellence rooted in the Chinese context, including moral education as a fundamental task, inheriting and innovating national culture as a spiritual core, serving the nation's strategic needs as a basic goal, providing education programs meeting people's needs and expectation as an essential objective, and developing world-class subject disciplines and enhancing faculty quality as important starting points. Wang et al. (2019) combine their arguments with President Xi Jinping's opinions on university development and propose enhancing university effectiveness by consolidating universities' advantages and features, emphasizing on education equity, as well as shaping modern campus culture and further promoting comprehensive reform in universities. Guan (2016) analyzes the principles of building world-class universities with Chinese characteristics and proposes to explore universities' uniqueness embedded in the Chinese context, to focus on disciplinary development to support national and regional innovation, to pursue excellence while contributing to social and national needs, to build a modern university system by integrating traditional and local culture.

Research Related to Foreign Experience. Existing studies emphasize studying the successful experience of global top universities, so as to inspire China's world-class university development. Xue and Liu (2019) review the experiences of top universities in Singapore and summarize the lessons for emerging economies. They suggest that China should establish its culture to encourage innovation and entrepreneurship, recruit high-quality faculty, promote higher education internationalization, and further enhance university governance and management. Liang and Wei (2018) investigate how Switzerland broke through the dominance of U.K. and U.S. in global higher education market by building academic excellence and became one of the countries with the highest global innovation index. They argue that China should strengthen the government's role in decision making, fully develop universities' role in daily practices, and enhance internationalization activities of faculty and graduate students to promote research and innovation. Liu and Zhang (2016) summarize the common features of excellence initiatives in Germany, France, Russia, Japan and ROK. They argue that Chinese government should strengthen the financial and policy support to excellence initiatives, integrate regional higher education resources, form a diversified and well-connected higher education system, and improve a dynamic evaluation and funding system to reward the high-performing institutions while eliminating under-performing institutions. The comparative analysis on international experience reflects the guidance of government and the autonomy of universities are equally important in the pursuit of academic excellence.

Research on Developing World-Class Disciplines. Since the Double World-Class Project, the development of world-class disciplines has increasingly become a heated topic for research. Based on the influence of the Double World-Class Project on universities' discipline reform, Hu (2019) proposes approaches to develop quality disciplines, including integrating several related or similar disciplines into discipline clusters, breaking through subject boundaries and forming inter- and cross-disciplines, and developing an ecosystem to restructure subjects and disciplines. Wu (2019) summarizes the distribution of Chinese universities in global discipline rankings and suggests building a sustainable disciplinary ecosystem and reinforcing "brand" disciplines. Other researches focus on reforming evaluation methods and student development through strategic planning.

6.1.2 Latest Research in the World

To investigate the latest research of excellence initiatives in the world, "excellence initiative" and "education" are searched as the key words in Web of Science (WOS), and the proportions of academic articles on excellence initiatives over the total number of articles in education from 2012 to 2021 are calculated (see Fig. 10). During the 10-year period, about 1,300 papers related to "excellence initiative" were published, accounting for about 0.10% of total research articles in education and about 0.33% of total research articles in higher education. These data show that

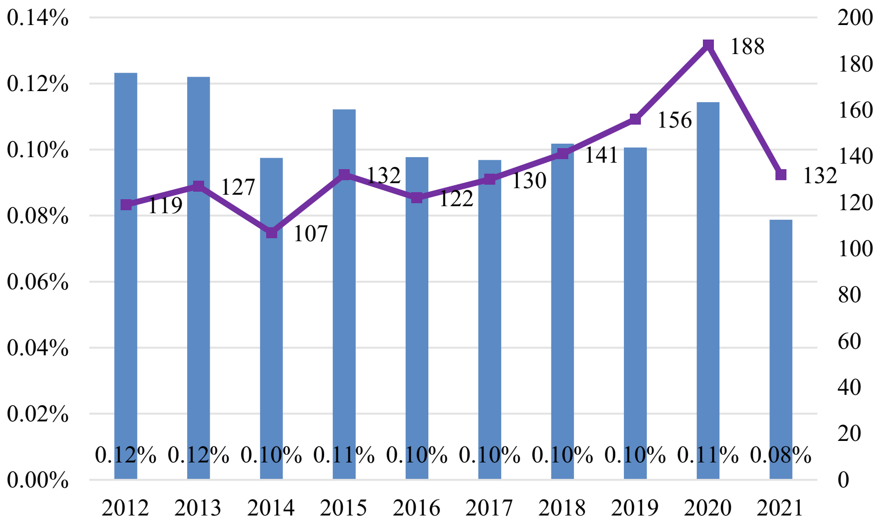

Fig. 10 Number and proportion of articles on "excellence initiatives" over total articles in education research worldwide (2012–2021). *Source* Compiled from search results from WOS

"excellence initiatives" are an important topic of educational research. During the past 10 years, the total number of educational articles has rapidly increased from 96,000 to 167,000, while the proportion of articles on "excellence initiative" has remained stable in range of about 0.08–0.12%. In these 10 years, a number of countries launched excellence initiatives and pursued world-class university movements, reflecting in increasing research interests in such topics.

Existing literature related to "excellence initiatives" mainly focuses on outcomes of these projects. One such focus is on the effect of these initiatives' on promoting scientific research. De Filippo et al. (2016) analyze the research output of Spanish universities after the implementation of Spain's Campus of International Excellence. The results show that the number of academic articles published on *Nature* and *Science* by these universities increased, which means the quality and productivity of scientific research improved. Lehmann and Stockinger (2019) investigate the entrepreneurship activities of Germany universities after they have participated in Excellence Initiative. They find that the cooperation between universities and industries as well as the number of patents increased.

The second research focus is excellent initiatives' effect on the mobility of scientific research talents. Cuntz (2016) argues that excellence initiatives have attracted overseas talents and intensified the international competition for elite scientists among the countries with similar policies. According to the records of the European Research Council, experts choose countries with high-quality scientific system, rather than countries which provides more funds than their homeland. Tsvetkova and Lomer (2019) investigate the competitiveness of the Project 5–100 universities in global talent market. They find that, with the influence of the project, these universities seek to recruit more outstanding scientists from all over the world, work to build excellent academic reputation with the help of scientific research breakthroughs, both of which promote the mobility of scholars.

Another popular research focus is excellence initiatives' impact on national education system. Egorov et al. (2020) argue that, since the beginning of the twenty-first century, Russia has strived to build a stronger higher education system. Since then Russia has merged regional universities, established federal universities, and promoted excellence initiatives to enhance universities' global competitiveness and contribute to national education and research. It is pointed out that the task of Russian higher education system has been transferred to comprehensively promoting socio-economic development and enhancing innovation potential. Highman (2020) also recognizes France's series of strategies to establish excellence centers, attract international students, and adjust the curriculum and research plans of HEIs, which help France maintain its leading position in higher education worldwide. Moreover, France has even reorganized and consolidated a number of universities to enhance their influence and to further improve its higher education system.

6.2 Research on Evaluating Excellence

Despite achievements, China's further development of excellence initiatives has hit bottlenecks. On the one hand, it is urgent for China to change its focus from quantity to quality development and to promote the deep development of higher education. Yu and Zhang (2019) compare the research productivity of universities of China's Double World-Class Project, the Ivy League in the U.S., and the U.K.'s Russell Group.[6] They argue that, although the research quality of Chinese universities has been on the rise, compared with the U.S. and the U.K., there is still a gap in research quality and influence. They note that the academic output of Chinese universities mainly relies on the cooperation within Chinese institutions while international cooperation should be strengthened. Fan and Du (2019) explore comments from social media and leading academics on China's Double World-Class Project and summarize the existing problems. These problems include nepotism preventing the diversification of teaching staff, a lack of emphasis on critical thinking, and a lack of balance between the planning and implementation of international strategies. On the other hand, the misunderstanding of policies hinders the development of Chinese higher education. Zhou and Zong (2019) point out some problems in China's Double World-Class Project. For example, the concentration of quantitative and intangible resources on top universities have led to a weak bottom of higher education system. The pursuit of quick breakthroughs in certain disciplines has disturbed the discipline ecosystem, and the identity labels generated by key university projects have resulted

[6] The Ivy League includes eight leading universities of the U.S., and the Russell Group includes 24 leading universities of the U.K.

in competitive barriers among universities. To tackle these issues, Chinese scholars have proposed new approaches to evaluating "excellence" by dividing into evaluation of world-class universities and world-class disciplines.

6.2.1 Evaluation of World-Class Universities

Evaluating the performance of world-class universities is conducive to guiding the reform of universities and promoting competition. Zhong et al. (2019) perform a quantitative evaluation on 42 Double World-Class universities from the perspective of National Natural Science Foundation of China (NSFC), in which they set the number of NSFC projects, the amount of funds, and the number of project leaders as key indicators for evaluating basic research competitiveness. After statistical analysis, they find clear gaps among the 42 universities. Feng et al. (2019) propose that the evaluation system of world-class universities should not only reflect Chinese characteristics, but also conform to international standards. They build an evaluation system that consists of four dimensions: talent training, scientific and technological research, social influence and international reputation, and assign weights to them. Specific indicators include teaching quality, academic strength, scientific and technological projects, scientific and technological platforms, alumni donations, influence on media, international faculty members and students, and academic influence. Their evaluation results show that China's world-class universities have made strong achievements as a whole. Cui et al. (2017) argue that the criteria of evaluation system of world-class universities should be optimized. They believe it is necessary to take talent training and teaching quality as key tasks and assign maximum weights to them, so as to guide universities in emphasizing and improving the quality of teaching, the quality of doctoral education, the strength of young scientific research talents training and the academic output of research teams. Many scholars have also pointed out that teaching quality is important in the evaluation of world-class universities, as it helps to change universities' one-sided focus on scientific research indicators and urges universities to focus on teaching, rather than solely on rankings.

6.2.2 Evaluation of World-Class Disciplines

Evaluating the effectiveness of discipline development helps universities better understand their current development level, their strengths and weaknesses, and formulate discipline-specific development strategies. Discipline evaluation is an important method to measure the quality of disciplines. Based on the conditions of China, many scholars have made in-depth research on the connection between the development of world-class disciplines and the discipline evaluation conducted by MOE of China. Xu (2018) argues that discipline evaluation from MOE guides the development of world-class disciplines; therefore, evaluation targets should focus on several key disciplines rather than all disciplines, the evaluation index should focus on the integration of system rather than core elements, and evaluation concepts should focus on discipline systems rather than disciplines themselves. The improvement of these three aspects could promote the evaluation of China's world-class discipline development. Zhou and Zhang (2018) point out the different criteria of discipline evaluation and the selection of world-class disciplines. They argue that the development of world-class disciplines gives more emphasis to state security and state interests. It also requires the development of a number of new disciplines and interdisciplinary courses that cover the fields of philosophy, social sciences, natural sciences and engineering technology. Zhang (2019) argues that discipline evaluation should serve the development of world-class disciplines, and the target of discipline evaluation could be further adjusted to serving the Double World-Class Project. Moreover, the subordinated functions of discipline evaluation such as motivating the competition of rankings and accountability should be emphasized. Discipline evaluation of MOE could be used as one method to underpin the development of world-class disciplines, but the different focuses of discipline evaluation and world-class discipline development should be considered.

6.3 Research on Innovative Workforce Development

Several studies concentrate on excellence initiatives' motivation on innovative workforce development. Scholars propose that the implementation of excellence initiatives would optimize the methods of teaching and learning, improve the standards of moral education, and promote students' diversified career development.

6.3.1 Transforming Teaching and Learning

Since the 1990s, China has carried out various projects of building key universities and has made great achievements. With the progress of the Double World-Class Project, many scholars argue that the methods of training talents in world-class universities can be further optimized. Wang and Gao (2018) find that the Double World-Class Project has promoted education reform and innovation and many Chinese top universities have begun to practice new talent training approaches. For example, Peking University adopted diversified approaches for student development, including interdisciplinary teaching and learning, liberal arts education, general education, and core curriculum. Nanjing University established a "3-3" model for developing undergraduate students' innovative skills and talent. Ma (2016) proposes recommendations to develop world-class undergraduate education, including developing small-size class teaching, promoting research-based learning, enhancing knowledge structure, emphasizing students' choices, integrating practice with theoretical studies, and eventually forming an educational model of combining class instruction, practicum, and campus culture. To achieve world-class status, Chinese universities should emphasize student-centered and well-rounded education.

6.3.2 Emphasizing Moral Education in Student Development

One of the most important objectives of the Double World-Class Project is to strengthen moral education (*lide shuren*) (MOE et al., 2022b). Moral education aims at developing students' moral quality and has been fully integrated in the process of student development. Zhang (2020) recognizes moral education as an integral part of the Double World-Class Project and a strategic support system. Li and Wu (2020) argue that ideological education plays an important role in moral education, and should be integrated into teaching and learning activities, so as to shape a discipline system of philosophy and social science with Chinese characteristics. Wang (2020) compares moral education of top U.S. universities and some Chinese Double World-Class universities and suggests that moral education could achieve better results through university leaders' guidance. A well-organized curriculum system, scientific research, and campus culture all contribute to developing moral education.

6.3.3 Encouraging Diversified Career Development for Students

Diversified paths should be encouraged in terms of students' career development, which can be considered as an important form of education output. Li et al. (2019) find that doctoral students at Chinese universities tend to choose academic professions after graduation, as the proportions of doctoral graduates at the two types of universities (Class A and Class B) within the Double World-Class Project reach 65.73% and 83.45%. Xu and Shen (2019) analyze graduates' employment at 63 Double World-Class universities and find that doctoral graduates' career paths have become increasingly diversified in recent years. Despite academic professions being the primary career choice, the number of graduates choosing jobs in industry has increased, with a decrease in graduates pursuing employment in government organizations. Training doctoral student is an essential task of top universities. While Chinese doctoral graduates are enthusiastic for academic work, with the excellence initiatives implemented, doctoral graduates tend to seek diversified career paths.

7 National Policies

7.1 Fundamental Policies of China's Excellence Initiatives

Before the launch of the Double World-Class Project in 2015, China's excellence initiatives mainly consist of Project 211 (launched in 1995) and Project 985 (launched in 1998). Although these two projects have been officially integrated into the Double World-Class Project, they have made the foundation of China's excellence initiatives and greatly promoted the development of Chinese higher education in the early twenty-first century.

7.1.1 Project 211 and Related Policies

In 1995, Chinese National Education Commission (the predecessor of MOE) launched Project 211 and issued its overall plan. The project aimed at developing the overall conditions and environment of Chinese universities, improving key disciplines and public service system of higher education, enhancing student development, and raising international reputation of Chinese HEIs. The plan proposed to eventually develop 100 key universities and a number of key disciplines (National Education Commission, 1995). Altogether, 94 universities were funded in the first two rounds of the project.

In 2002, during the period of China's 10^{th} Five-Year Plan, MOE and the other two central agencies issued guidelines concerning strengthening the development of Project 211, which highlighted the targets of improving education quality, promoting innovation mechanisms, adjusting discipline structure, further strengthening information technology, and improving the transformative ability of scientific research (National Planning Commission et al., 2002). At the same time, the guidelines defined the strategic significance of Project 211, which is to serve the national strategy of development by relying on science and education, help the transformation towards knowledge economy, and improve higher education (*ibid*). In 2003, Chinese government issued regulations on the implementation of Project 211, which clarified each stakeholders' responsibilities and specifies procedures and management of the project, including budget, expenditure, final accounts, and supervision of special funds (Ministry of Finance et al., 2003; Office of the Inter-Ministerial Coordination Group of Project211, 2003). After five rounds of application, 116 universities including branch schools were selected as Project 211 universities and received long-term support from the project. Project 211 continued until 2016, when MOE declared the relevant policy documents of Project 211 invalid (MOE et al., 2016). In 2019, Project 211 was officially integrated into the Double World-Class Project (MOE, 2019).

7.1.2 Project 985 and Related Policies

At the end of the 1990s, China issued an action plan for education revitalization, with the goal of developing a number of world-class universities and world-class disciplines (MOE, 1998). This action plan opened the curtain of Project 985. This project had been implemented in three phases since 1999. Within the first round, 35 universities were selected to develop world-class universities. In 2004, Chinese government issued guidelines concerning strengthening the development of Project 985. The guidelines particularly stated to further develop a number of world-class universities with international reputation via governance reform, platform building, conditions support, and international cooperation (MOE & Ministry of Finance, 2004). In the second phase starting in 2004, four universities were added and a complete list of Project 985 was published. In 2013, during the third phase, MOE issued regulations on the implementation of Project 985 to strengthen project management, including the selection and evaluation processes (MOE & Ministry of Finance, 2013). Similar to Project 211, MOE declared the relevant policy documents of Project 985 invalid in 2016. Subsequently in 2019, Project 985 was officially integrated into the Double World-Class Project (MOE et al., 2016; MOE, 2019).

7.2 National and Local Policies of China's Double World-Class Project

Since the launch of the Double World-Class Project in 2015, Chinese government has successively issued a series of policies in the following years to construct the policy framework of the project and improve the practice. The first round of the project has been completed and the second round starts in 2022. Moreover, Shanghai has also issued several policies related to the Double World-Class Project following the guidance of Chinese central government and based on its local conditions.

7.2.1 Development Stages of National Policies

The Early Preparation Stage. Since China formally launched the Double World-Class Project, MOE and other central agencies have successively issued policies related to the overall plans, implementation procedures, and evaluation measures of the project (see Table 3). In the early preparation stage, Chinese central government formulated the overall plan and the expected implementation measures. In 2015, the *Overall Plan* of the Double World-Class Project was promulgated, and it outlines the overall requirements, development tasks, reform tasks, supporting measures, and organizations of the project (the State Council, 2015). It clearly defines the goal of promoting a number of leading universities and disciplines to reach world-class level, gradually improving the overall strength of higher education, and building China as a powerful higher education country; it emphasizes teaching staff, innovative talents, scientific research, cultural heritage, and achievements transformation (*ibid*). In 2017, after more than one year's research and discussion, the *Implementation Measures* of the Double World-Class Project were published, which discloses the selection conditions, selection procedures, support methods, dynamic management, and other project management elements (MOE et al., 2017b). Institutions selected for the Double World-Class Project should be widely-recognized leading universities, and high-quality, influential, and irreplaceable disciplines (*ibid*). Government departments, universities, and industry organizations form an expert committee to review and decide upon the list of institutions selected for the Double World-Class Project. Chinese central government and local governments provide special financial support and a dynamic adjustment mechanism has been made based on a five-year cycle (*ibid*).

Table 3 National policies related to the Double World-Class Project

Issue dates	Policy documents
October 24, 2015	*The Overall Plan for Promoting the Construction of World-Class Universities and World-Class Disciplines* (hereafter the *Overall Plan*)
January 24, 2017	*Implementation Measures for Promoting the Development of World-Class Universities and World-Class Disciplines (Provisional)* (hereafter the *Implementation Measures*)
September 20, 2017	*Notice on Issuing the List of World-Class Universities, Universities Designated to Develop World-Class Disciplines, and World-Class Disciplines* (hereafter the *List of the Project*)
August 8, 2018	*Guidelines on Accelerating the Development of the Double World-Class Project* (hereafter the *Guidelines*)
December 30, 2020	*Evaluation Measures of the Effectiveness of the Double World-Class Project (Trial)* (hereafter the *Evaluation Measures*)
January 26, 2022	*Guidelines on Further Promoting the Development of the Double World-Class Project* (hereafter the *Guidelines on Further Promotion*)
February 9, 2022	*Notice on Publishing the List of the Second Round of the Double World-Class Project* (hereafter the *List of the Second Round*)

Implementation of the Project. The first round of the project ended in 2022, when a second round was also launched. During the first round, the initial list of the selected universities was officially announced in 2017, and then the project entered an implementation stage. The first group, as mentioned in 1.3 and 2.1 of this chapter, included 42 universities aiming for world-class status and 140 universities designated to develop world-class disciplines (MOE et al., 2017a). In 2018, Chinese government issued the *Guidelines* for the Double World-Class Project, which emphasizes talent training as the essential task (MOE et al., 2018). The document puts forth recommendations to comprehensively deepen the reform of university and promote the in-depth development of disciplines, so as to form a coordination of universities and disciplines (*ibid*). In 2020, the *Evaluation Measures* was published, which provides evaluation criteria for the project. The evaluation process mainly includes midterm self-evaluation and final evaluations being conducted by expert committee. Evaluation results provide evidence for future funding in subsequent rounds (MOE et al., 2020).

The Second Round. The second round of the project began in 2022. In 2022, Chinese government published the *Guidelines on Further Promotion* of the project, which puts forward the strategic positioning of the new stage and explicitly prioritizes high-quality development (MOE et al., 2022b). In the same year, the *List of the Second Round* was published and seven additional universities were added to the list, with a total of 147 universities having been selected by the project (MOE et al., 2022a). However, the disciplines of 15 universities from the first-round were publicly warned or revoked (*ibid*). The second round does not distinguish world-class universities and universities that are designated to develop world-class disciplines; instead, it emphasizes on innovative breakthroughs (*ibid*).

7.2.2 Key Features of Recent National Policies

The contents of China's Double World-Class Project reflect some key features including focusing on Chinese characteristics, implementing dynamic management, and emphasizing coordination among stakeholders.

Focusing on Chinese Cultures and Values. Relevant plans of the Double World-Class Project highlight the need to build world-class universities and disciplines to serve the local needs, enhance the national development, and contribute to people's well-being (MOE et al., 2018). The *Evaluation Measures* incorporates various evaluation dimensions and indicators with Chinese characteristics. For example, the evaluation of "scientific research" requires universities to develop Chinese philosophy and social sciences. The evaluation of "cultural inheritance and innovation" requires universities to inherit and develop Chinese traditional culture (MOE et al., 2020). The *Guidelines on Further Promotion* points out that the basic principles of the Double World-Class Project are embedded in the Chinese context, highlighting Chinese advantages, and exploring paths to deepen socio-economic transformation in China (MOE et al., 2022b).

Implementing Dynamic Management. Compared with the relatively fixed list of Project 211 and Project 985, the Double World-Class Project implements a dynamic mechanism of rewarding high-performing universities and eliminating the underperforming ones, and emphasizes this process. The *Overall Plan* designs a five-year cycle and decides to provide dynamic support to universities based on performance evaluation, namely, Chinese government increases support for universities that have made good progress and reduces support for universities that lack progress (The State Council, 2015). Chinese government provides follow-up guidance on the organization and implementation of the project, dynamically monitors the development process, and works to discover timely problems (*ibid*). The *Implementation Measures* elaborates on the process of dynamic management, which requires universities to publish middle and final self-evaluation reports. An expert committee also provides advice according to the results of self-evaluation and third-party evaluation (MOE et al., 2017b). Dynamic management requires changing the fixed identity of universities and establishing an "in and out" adjustment mechanism for universities and disciplines (*ibid*). The *Evaluation Measures* stipulates that performance evaluation should combine usual dynamic monitoring with periodic evaluation, and integrates continuous tracking, monitoring, and evaluation in the development process and results (MOE et al., 2020).

Emphasizing Coordination among Stakeholders. Emphasizing coordination and joint efforts among stakeholders is another key point of the Double World-Class Project. Conducting the project is not only the responsibility of Chinese government and the universities. The *Overall Plan* suggests that the government, society, and universities should form a pattern covering diversified investment and joint efforts, while relevant government departments and industry enterprises should be encouraged to actively participate in the project. It also encourages universities to broaden their financing channel and actively attract social donations (the State Council, 2015). The *Guidelines* establishes joint efforts of the Double World-Class Project covering the responsibilities of university, support from local governments, guidance from Chinese central government, and participation of third-party evaluation agencies (MOE et al., 2018). The *Guidelines on Further Promotion* seeks to improve the innovation system by realizing the collaboration of major scientific research platforms, integrating resources and forming joint forces. In order to guarantee the implementation of the project, it was important to form a pattern of diversified investment, establish and improve a long-term investment mechanism which includes the coordination of Chinese central government, local governments, enterprises and other social sectors (MOE et al., 2022b).

7.2.3 Local Policies in Shanghai

Chinese local governments generally rely on the guidance of Chinese central government to carry out the Double World-Class Project, so there are very few local policies related to this project. However, the development level of higher education in different provinces and cities is different, and local governments should consider their conditions in practices. For example, Shanghai, with its strong higher education power, has issued policies related to the Double World-Class Project, such as the *Implementation Guidelines of Shanghai*, the *Implementation Plans of Shanghai*, and *the 14th Five-Year Plan of Shanghai Education* (see Table 4).

In the beginning of the Double World-Class Project, Shanghai Municipal People's Government issued the *Implementation Guidelines of Shanghai* in response to national policies in 2018. Based on the national policies, the *Implementation Guidelines of Shanghai* includes some local contents. It seeks to support universities funded by the local municipal to be included in Double World-Class Project. It enhances universities' autonomy via the reform of decentralization, management, and service, and reinforce strong local funding (Shanghai Municipal People's Government, 2018). At the end of the first round in 2021, Shanghai government issued the *Implementation Plans of Shanghai*. Focusing on the next five years of the project, this policy requires that Shanghai serve the national strategy and develop Shanghai's new advantages (Shanghai Municipal Education Commission et al., 2021). It argues that Shanghai

Table 4 Shanghai local policies related to the Double World-Class Project

Issue dates	Policy documents
February 22, 2018	*Implementation Guidelines of Shanghai on Promoting the Development of World-Class Universities and World-Class Disciplines* (hereafter the *Implementation Guidelines of Shanghai*)
July 21, 2021	*Implementation Plans of Shanghai to Accelerate the Development of World-Class Universities and World-Class Disciplines (2021–2025)* (hereafter the *Implementation Plans of Shanghai*)
July 26, 2021	*The 14th Five-Year Plan of Shanghai Education Development*

Sources Compiled from Shanghai Municipal People's Government and Shanghai Municipal Education Commission should emphasize university governance reform, top innovative talent development, high-quality teaching staff, students' innovative skills, international cooperation, and focus on promoting Peak and Plateau Discipline Development Plan, High-level Local University Development Plan and University Innovation Ability Promotion Plan[7] (*ibid*). Similarly, *the 14th Five-Year Plan of Shanghai Education* specifically requires further implementing the Double World-Class Project and improving educational quality (Shanghai Municipal People's Government, 2021). It seeks to support the selected universities that are affiliated to central ministries (these universities are usually top universities in China), reinforce their leading positions, further enhance their contributions to the country, and ensure strong financial support for the project (*ibid*).

Shanghai's practice shows it attaches great significance to maintain and develop local advantages, emphasize university governance reform, and encourage the participation of local universities in the project. The policy documents have repeatedly mentioned the existing local advantages such as Peak and Plateau Discipline Development Plan (Shanghai Municipal Education Commission et al., 2021). The *Implementation Guidelines of Shanghai* clarifies the foundation for discipline development, optimization of discipline distribution, long-term strategic cooperation between central ministries and local municipal government, and higher education resource concentration (Shanghai Municipal People's Government, 2018). The *Implementation Plans of Shanghai* also emphasizes maintaining existing planning. Shanghai is committed to promoting governance reform in higher education to strengthen the inner motivation of "double world-class" development (Shanghai Municipal Education Commission et al., 2021). The *Implementation Guidelines of Shanghai* argues that the autonomy of university is the breakthrough that will solve management problems while the reform of decentralization, management and service in higher education should be used as a lever to promote innovations in education system (Shanghai Municipal People's Government, 2018). Shanghai argues that the universities of the Double World-Class Project should play a leading role and motivate leading local universities to improve and participate at the world-class level (Shanghai Municipal People's Government, 2021). The *Implementation Plans of Shanghai* emphasizes that Shanghai local universities that are affiliated to central ministries should fully make use of their advantages, promote the diversified development of local universities, and encourage them to pursue excellence in their fields and work to enter the list of the Double World-Class Project (Shanghai Municipal Education Commission et al., 2021).

[7] These three plans are initiated by Shanghai government, aiming to improve the innovation ability of HEIs of Shanghai, encourage scientific breakthroughs, improve the quality of talent training, and accelerate the development of world-class universities and disciplines.

7.3 *Policies of Excellence Initiatives in Other Countries*

Policies of excellence initiatives in different countries are closely connected with their local conditions. Generally, excellence initiatives in developed countries and emerging economies have presented different characteristics regarding the goals, contents, and evaluation methods.

7.3.1 Developing Excellence Initiatives in Developed Countries.

Goals of Excellence Initiatives. The main purpose of excellence initiatives in developed countries is to improve international competitiveness. France's IDEX aims to promote the integration of disciplines, and advance technological innovation and technical transformation, so as to boost the French economy (MOE of France, 2010c; Zhang & Zhang, 2016). Japan's Top Global University Project aims to improve the international compatibility and competitiveness of higher education through various measures, such as raising the proportion of international students and faculty members, setting performance indicators, and promoting English as a medium of instruction (MEXT of Japan, 2014b). Germany's Excellence Strategy (the continuation of Germany's Excellence Initiative) boosts German research capacity by strongly supporting scientific research in universities (German Research Foundation, 2019a).

Contents of Excellence Initiatives. At present, the existing excellence initiatives of developed countries are mainly distributed in Central and Western Europe and East Asia. In terms of the duration of funding, France's IDEX is from 2012 to 2022 (MOE of France, 2010b), Germany's Excellence Strategy, which is the continuation of Excellence Initiative, is from 2019 to 2025 (German Research Foundation, 2019a), and Japan's Top Global University Project is from 2014 to 2023 (MEXT of Japan, 2014c). In terms of the key point, IDEX, Excellence Strategy and Top Global University Project belong to academic development category, as they focus on academic excellence (Feng et al., 2017). In terms of the funding scale, IDEX selected 11 universities, Top Global University Project selected 37 universities, and Excellence Initiative selected 14 universities.

Evaluation of Excellence Initiatives. In terms of the selection process, all of these projects are highly competitive and have a pre-selection stage, and the selection generally involve multiple stakeholders. France's IDEX includes a pre-selection stage and formal selection stage; it employs external experts to assist in the evaluation, and the selection results and funding amounts are signed and confirmed by French Prime Minister (MOE of France, 2010c). Germany's Excellence Strategy includes draft proposal stage and complete proposal stage, and it is investigated by a special assessor in the whole process (German Research Foundation, 2019b). In terms of the selection criteria, excellence initiatives of developed countries mainly focus on four aspects: research, personnel, management, and cooperative partnership. IDEX uses a three-level marking system, and it emphasizes the intensity of research, personnel training, leadership of organizations, resource allocation, and cooperative economic partnerships (MOE of France, 2010c). Germany's Excellence Initiative uses a five-grade marking system, it emphasizes originality and quality of research, academic experience of faculty, the management of development planning, personnel, finance, infrastructure framework, the diversity and equality of team members, and cooperation with other institutions (German Research Foundation, 2005). Top Global University Project pays attention to the internationalization of the project (MEXT of Japan, 2014c).

7.3.2 Developing Excellence Initiatives in Emerging Economies

Goals of Excellence Initiatives. The purpose of excellence initiatives in emerging economies is to improve the strength of scientific research at the world-class level. Emerging economies aim to improve the quality of a number of universities and then improve the overall strength of scientific research of the country. For example, India's UPE aims to support a number of HEIs to reach world-class level of scientific research and teaching, and then drive the overall national development (University Grants Commission, 1997b). Russia's Project 5–100 also emphasizes integrating into the global education market (Ministry of Education and Science of the Russian Federation, 2013).

Contents of Excellence Initiatives. At present, existing excellence initiatives of emerging economies are mainly distributed in Asia and Eastern Europe. In terms of key point, India's UPE, Russia's Project 5–100, and Vietnam's New Model University Project belong to the academic development category, which focus on academic excellence. In terms of funding scale, the numbers of funded institutions in emerging economies are quite different, with most countries funding around seven institutions and a few countries funding dozens of institutions. Take India's UPE as an example, during the period of the ninth Five-Year Plan of India (1997–2002), five universities received financial support from Indian University Grants Commission (University Grants Commission, 1997a). During the period of the 10th Five-Year Plan (2002–2007), the 11th Five-Year Plan (2007–2012), and the 12th Five-Year Plan (2012–2017), UPE funded four, six and 10 universities respectively (University Grants Commission, 1997a). Russia's Project 5–100 selected 15 universities in 2013 and six universities in 2015 (Ministry of Education and Science of the Russian Federation, 2013). Vietnam's New Model University Project has funded three universities (Ministry of Education & Training of Vietnam, 2008).

Evaluation of Excellence Initiatives. Both international and domestic experts are invited to evaluate excellence initiatives in emerging economies, including university senior management, academics, scholars, etc. For example, UPE invites educators, quality management experts, discipline experts, and staff of Indian University Grants Commission to make decisions together (University Grants Commission, 1997b). Vietnam's New Model University Project is not a project created by selection, but a new university established by Vietnam's MOE and foreign universities (Asian Development Bank, 2010). The evaluation processes of excellence initiatives of these emerging economies are as strict as that of developed countries, which include annual evaluations, midterm evaluations, and final evaluations. UPE has a midterm evaluation conducted by a standing committee that includes the chairman of Indian University Grants Commission, and a final evaluation conducted in the last year of the project (University Grants Commission, 1997a). The chairman of Indian University Grants Commission visits every university, evaluates the university's performance and achievement based on the goal of the project. Evaluation results are used to make suggestions on professional plans, for the universities' development in the next stage and for the consideration and revision of the standing committee (University Grants Commission, 1997a). The selection criteria of emerging economies are slightly different from that of developed countries, as their criteria place greater emphasis on student development.

8 Summary

8.1 Internationalization: The Standard Consensus of Excellence Initiatives

The excellence initiatives of various countries have reached a consensus of maintaining global vision while integrating with national strategies. Global concepts, standards and actions are important strategic consensus of excellence initiatives. Excellence initiatives aim to actively promote the development of world-class universities and disciplines, tackle major global challenges through innovative breakthroughs in scientific research, and make contributions to global common goods. International standards are essential in designing and implementing excellence initiative. Through these initiatives, universities are expected to reinforce their leading positions in the increasingly competitive global market. To reach the top 100 in global university rankings is commonly regarded as an intuitive indicator for achieving excellence. Excellence initiatives focus on strengthen university competitiveness as a whole as well as individual disciplines, actively promoting international collaboration and communication with world-top research institutions and researchers, and forming a solid global network. Because of various global crises in recent years, the process of internationalization of higher education has been hindered. Although the process of globalization has been impacted, global society will keep developing towards "a community of shared future for mankind". The trend of internationalization of higher education will not be reversed, but it might not be further expanded to all fields. Governments may not choose strategies which infiltrates international attributes into all levels and fields in their excellence initiatives. More likely, based on the actual strength of their higher education, different countries will focus on specific aspects of international development, such as international cooperation of advantaged disciplines, and international exchanges of faculty members and students, so as to promote more focused academic excellence.

8.2 Serving the Country: The Attribute Consensus of Excellence Initiatives

National attributes of excellence initiatives are also evident. The goal setting of excellence initiatives aligns with national strategies. Excellence initiatives of many countries have put forward the demands of defending the long-term benefits of the country, and aim at furthering the development of science, technology, society, economy, and culture. The state plays a key role in promoting excellence initiatives, as government departments or related institutions manage the investment, midterm supervision, and outcomes evaluation of excellence initiatives. The success of excellence initiatives is closely connected to the state's investment and support. A few institutions with potential and advantage should be selected and funded, so as to maximize the spillover effect of key institutions and benefit national development. Countries concentrate higher education resources to organizing and promoting excellence initiatives, so excellence initiatives must reflect the will of the state and should inevitably take on the responsibility of continuously serving future national strategies. As opinions of nationalism has risen, the need to protect national interests has been reflected in excellence initiatives, and the specific measures include resolving bottlenecks by relying on the innovations of world-class research institutions and training elite talents in specific fields.

8.3 Tactical Plans: The Differences of Excellence Initiatives

Various countries have formed consensuses on the goals, key points, motivators, and targets of excellence initiatives as well as the efforts devoted to excellence initiatives. However, it should be noted that on the basis of these strategic consensus, there are differences in the tactical plans of countries. Based on the strategic consensus of enhancing international competitiveness, countries have chosen different tactics according to their development levels, such as improving international visibility and reinforcing international leading status. Based on the strategic consensus focusing on scientific research challenges, countries have chosen different tactics, such as making breakthroughs in specific research fields, developing cross-disciplinary integration, and strengthening the training of future scientific research leaders. Based on the strategic consensus that government should be the main motivator of excellence initiatives, governments of different countries have chosen their own tactics to support excellence initiatives directly, indirectly or through entrustment. As for the specific tactical plans for excellence initiatives, countries have chosen appropriate modes according to their own situation as well as their certain strategic consensus.

Due to the different conditions of higher education in different countries, tactical plans would differ. Specific implementation measures and strategies of excellence initiatives in different countries are influenced by many factors. What are the factors that affect the choice of tactical plans? To what extent have these factors affected the choice of tactical plans? How effective are different tactical plans in national strategies? These are the research questions and topics that can be further studied in the future.

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