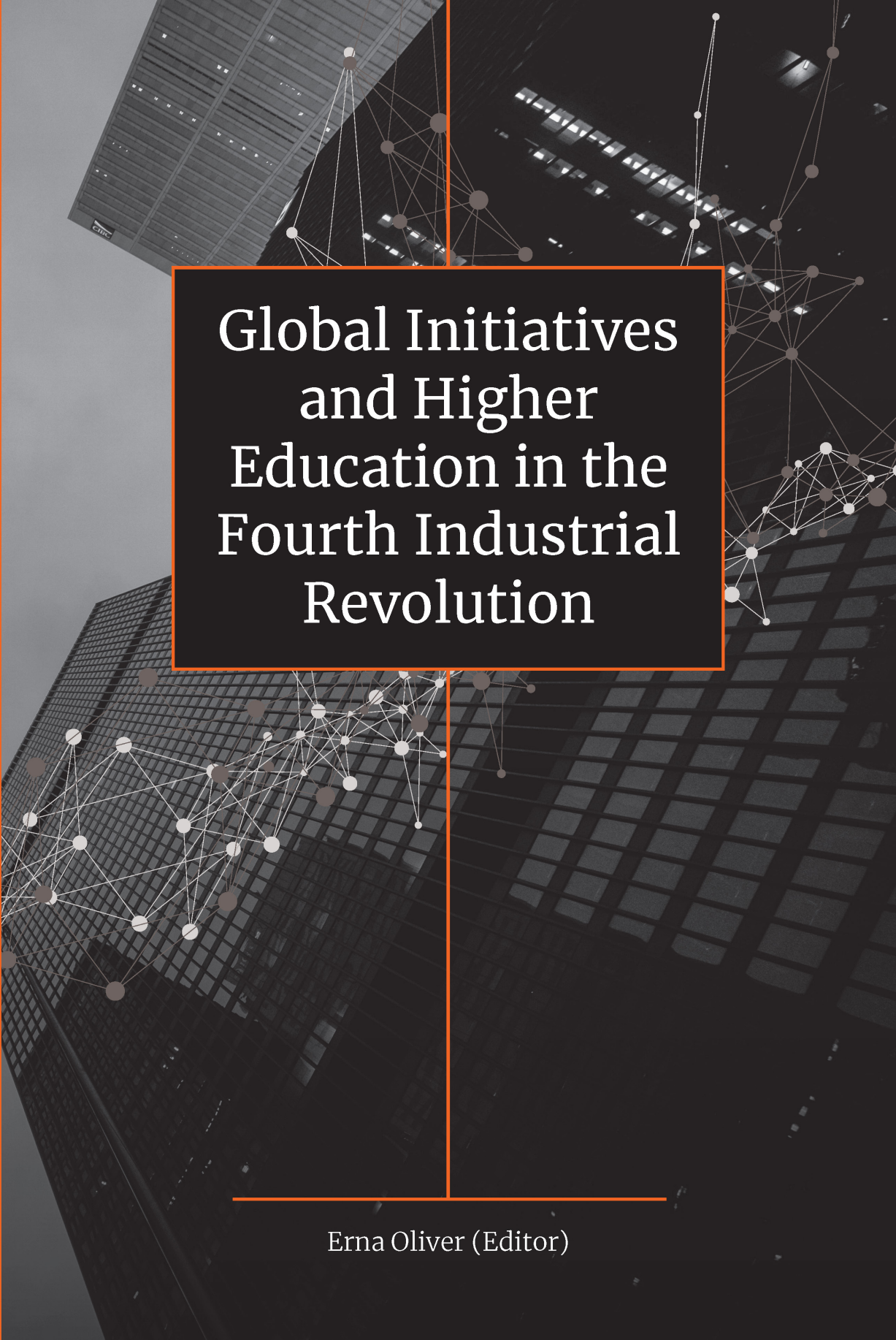

Global Initiatives and Higher Education in the Fourth Industrial Revolution

Erna Oliver (Editor)


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Introduction

Global Initiatives and Higher Education in the Fourth Industrial Revolution

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General Introduction to the Book

The world we are living in is complex and changing faster than most of us can keep up with. It is complex because we are experiencing several simultaneous revolutionary transformations. It is changing because un-learning and re-learning are uncontested parts of our daily lives – how else will we be able to operate new cellular phones or electric cars? Most people in the HE (higher education) sector will agree that the 4IR (Fourth Industrial Revolution) and other global events are constantly transforming and disrupting our lives and work.

Unfortunately, it seems as if HE is struggling to adjust to the demands set by the complex and fast changing world. In contrast to the previous revolutions (e.g., industrial, communication revolutions), where education played an instrumental role to implement change and development, it seems as if the current revolutions are leaving HE behind. This could make HE redundant and/or superfluous. The aim of this book is to take a broad overview of how the 4IR and some international initiatives towards sustainable development are interpreted in terms of HE and to identify some weak spots as well as opportunities and chances where HE must and should take action to ensure relevance and a sustained need for HE towards positive and sustainable transformation.

Already in 2015, the UN (United Nations) assembled its Agenda for Sustainable Development (UN 2015), challenging people and countries to start working *together* to assure a sustainable world, both economically and societal (Fukuyama 2018:47). Governments and the corporate world have taken steps to meet the new era with initiatives (also called upheavals/programmes/plans) like Industry 4.0 (Germany), Advanced Manufacturing Partnership and IIoT (USA), Industrie du Futur (France), Made in China 2025, Society 5.0 (Japan), Australia 2056, and Education 5.0 (Zimbabwe), to name

but a few. However, it seems as if most of these initiatives have sidestepped HE to a certain extent, as the government of Japan, for example, has indicated that HE is *lagging behind* (GJ 2015:6 of 18). Can HE find a place and cause to exist and contribute towards the disruptive and fluid revolutionary world? How will national governments, NGOs, business in general, and society at large be made to understand that HE has a significant role to play in initiating and sustaining international development, manufacturing and industry, and the development of much needed workplace skills if it is not done by the specialists of HE themselves?

Other issues addressed in this publication include new pathways for grand strategies and statecraft, practical leadership and partnership in times of unsettling change, the ongoing and vital role of internationalisation and globalisation of HE and training, distance education, and self-directed learning amidst a pandemic, as well as the ever-pressing issue of climate change.

4IR terminology like 'disruption,' 'innovation,' 'fluidity,' and 'profound and systemic change,' already form part of our normal speech. Klaus Schwab, the founder and executive chairman of the World Economic Forum (WEF), published his ground-breaking work, *The Fourth Industrial Revolution*, in 2016. In the foreword to this book, Marc Benioff (the chairman and CEO of Salesforce) claims that the 'technologies driving the fourth industrial revolution will fundamentally transform the entire structure of the world economy, our communities and human identities' (Schwab 2016:ii). Schwab himself confirms this by stating that the 4IR is a confluence of 'multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually' (Schwab 2016:8). This means that there will be a global transformation on both macro and micro levels and the challenge will be to keep our world human-centred within a technology driven environment.

The 4IR is only one of several revolutions that are revolving our world. The communication revolution (Harnad 1991), the societal revolution (Narvaez Rojas, Alomia Peñafiel, & Loaiza Buitrago (2021:5, 6 of 16), the educational revolution (Gerstein 2014), and the revolution in human self-awareness (Floridi 2014), are all influencing our lives and the way we see the future. These revolutions are intertwined with each other, and they have far-reaching implications for human life. The following brief summary paints the broad orientation lines and wide-ranging trends (mostly linked to the Western world) that provides a general background for and link between the 4IR, HE, and some global initiatives.

The Revolution-Ridden World

The Industrial Revolutions

The First Industrial Revolution

Between the late 18th century and the early 19th century, this revolution caused one of the most disruptive transformations in human history. Narvaez Rojas *et al*. (2021:4 of 16) name three important processes that made the transition possible: The invention of machines for manufacturing and production on a large scale, the ability to generate energy for use in industrialised transport such as trains and ships and the creation of organised labour to work in factories and mines. Results from this change included population growth, urbanisation, mass employment options as well as the exploitation of workers, and the expanding and improvement of communication (during the last stage of the Third Communication Revolution) through industrialised transport.

The Second Industrial Revolution

This revolution coincided with the first period of globalisation. It started in the late 19th century and ended in the early 20th century. Through the Bessemer process, it became possible to mass produce cheap steel (Encyclopaedia Britannica 2019). Advances in processing chemicals and energy sources like electricity and oil decreased production time and cost, boosted and internationalised the economy, while opening opportunities for long distance and international transportation networks that could move ideas and people globally (Narvaez Rojas *et al*. 2021:4 of 16). This overlapped with the start of the Fourth Communication Revolution with advanced technology such as cinema, radio, and the telegraph. On the negative side, unemployment grew and life was picking up pace, regulated by the clock and money. The African continent is seemingly to a large extent trapped here, due to geohistorical and geopolitical issues as discussed in chapters 8 and 9. In chapter 6, 'noopolitik' or information age statecraft is proposed as an alternative for the realpolitik of the colonisation period.

The Third Industrial Revolution

During the last quarter of the 20th century, the world started to move towards becoming an 'information society' (Narvaez Rojas *et al*. 2021:4 of 16) through the digital revolution that was founded on the development of the microchip and other electronic components that enhanced the Fourth Communication Revolution. PLCs (Programmable logic controllers) and robots further promoted automation (Desoutterttools 2022). While the internet and computers made life and work easier, the speed of change increased significantly, while the world shrank to a well-connected village.

Unfortunately not all countries and all people were equally benefitted. The American model of implementing this model is discussed in more detail in chapter 3.

The Fourth Industrial Revolution

This revolution does not denote a radical break with the past, as it builds on the Third Industrial Revolution through evolution while also impacting less diverse fields (Lee & Lee 2021:137). Characteristic is the blurring of lines and dissolving of boundaries between components and sectors into more liquid and interactive forms. The focus is on smart industry, big data, and the internet, while aiming for complete automation through cyber-physical systems (Narvaez Rojas *et al.* 2021:4 of 16). The 4IR will aid towards the creation of Society 5.0 and Education 4.0 with the focus on 'rehumanising in the age of machines' (Dervojeda 2021).

The Communication Revolutions

The First Communication Revolution

Before people developed speech, which gave rise to the first revolution in communication, they had to use actions, gestures, and voice sounds to convey ideas and information. The development of language, about 40,000 BCE, opened a different and advanced way of interaction between people.

The Second Communication Revolution

The development of writing, at about 10,000 BCE, denotes the second breakthrough in human communication skills. This allowed people to communicate over longer distances and asynchronously.

The Third Communication Revolution

The next revolution introduced the use of technology in communication in the Western world at about 1459 CE through the development of the printing press. This boosted the fast and global spread of information and news.

The Fourth Communication Revolution

Similar to what happened regarding the Third and Fourth Industrial Revolutions, the Fourth Communication Revolution built on and expanded the technology implemented during the Third Revolution. Already in the early 20th century, communication methods expanded with the added technologies of audio (radio) and video (cinema and television), which by the end of the century exploded into all the sophisticated technology-enhanced communication tools that we are currently using to communicate globally and beyond our own planet.

The Development of Society

Society 1.0

The hunting and gathering society started to craft tools and divide tasks. Men hunted and women gathered food, while fire was used for protection, light, heat, and food preparation (Narvaez Rojas *et al.* 2021:5 of 16).

Society 2.0

The moment that agriculture development progressed, people had the option to abandon the nomadic lifestyle to settle at locations where resources were readily available. The more permanent settlement options brought greater numbers of people together which led to the specialisation of trade and new career opportunities. Economy and politics became important. Transformation only set in as a result of the 1IR (First Industrial Revolution).

Society 3.0

The industrial society developed because of the automation and mass production of the 1IR. The population grew despite severe exploitation and before long the concept of human rights started to develop.

Society 4.0

Linked to the developments of the Fourth Communication Revolution, Society 4 is also called the information society. Things, people, and places got connected, using technology (Narvaes Rojas *et al.* 2021:6 of 16).

Society 5.0

Nowadays, the focus is moving towards the needs of people and the sustainability of life on our planet. Using all technological developments from the Third and Fourth Industrial Revolutions, implementing the advances from the Fourth Communication Revolution and the knowledge gained from the Human Revolutions in Self-Understanding, the aim is to develop a super smart society (cf. Medina-Borja 2017). In chapter 2, we will return to how this concept is being implemented, as well as its impact on HE and other countries. As already referred to, 'noopolitik' as discussed in chapter 6 will play an important part in the development of a super smart society. Chapter 7 adds to the development of a smart society through reference to the need for smart products, smart mobility, and smart logistics.

Revolutions in Self-Understanding

Without going into detail, we also need to take note of the significant changes that took place regarding human self-understanding. According to Floridi (2014), the first revolutionary change in human self-understanding

was instigated by Copernicus (1473-1543). Copernicus' finding that Earth is orbiting the sun 'displaced the earth from the centre of the universe' and forced people to reconsider their role and place in the solar system (Floridi 2014:87). The second major change in how we see ourselves and our relationships was brought about by the work of Darwin (1809-1882), who displaced us from the 'centre of the biological kingdom' by showing that species have evolved (and are still evolving) over time through natural selection (Floridi 2014:89). The psycho-analytic work of Freud (1856-1939) brought a 'radical displacement from our Cartesian certainties' (Floridi 2014:90). Floridi claims, '[T]oday we acknowledge that we are not immobile, at the centre of the universe (Copernican revolution), that we are not unnaturally separate and diverse from the rest of the animal kingdom (Darwinian revolution), and that we are far from being Cartesian minds entirely transparent to ourselves (Freudian or neuroscientific revolution)' (Floridi 2014:90). Floridi regards Alan Turing (1912-1954) as the father of the Fourth Revolution in Human Self-Understanding, and states that 'we are accepting the post-Turing idea that we are not Newtonian stand-alone and unique agents, we are informational organisms (inforgs), mutually connected and embedded in an informational environment (the infosphere) which we share with other informational agents, both natural and artificial' (Floridi 2014:94).

Developments in Education

Gerstein (2014) defines the changes in the education environment by linking Education 1.0, 2.0, and 3.0 with web services 1.0, 2.0, and 3.0. Huk (2021:42-44) expands this by adding Education 4.0 which aligns with Society 5.0 as well as the Fourth Communication Revolution and the 4IR.

Education 1.0

Education in this phase was educator-centred, done in a lecturing style with the students as passive recipients of information. The focus was on teaching students the ability to master their reading, writing, and basic mathematic skills, using non-interactive media.

Education 2.0

During this phase, the education process expanded to include interaction between the educator, other experts and students, and by means of content, using both synchronous and asynchronous communication methods (Huk 2021:38). The focus was on communication, contribution, and collaboration.

Education 3.0

During this phase, education was student-centred and unlimited in terms of time and space. Content was freely available, and the focus was on students

becoming active connectors, creators, and constructivists. Educators were acting as guides and facilitators. Chapter 9 provides guidelines on how South Africa (and other countries that find themselves far behind) can advance their education through effective learning methods.

Education 4.0

Here, education is focused on the individualised and specific needs of students. Learning takes place at the student's own pace and the process is unlimited in terms of time and space and media. Higher cognitive skills and transformative learning are prioritised (Huk 2021:40, 41). The main education responsibility is transferred to the students. Sustainability of human life and the future of the planet are the focus areas of this problem-solving educational structure. Education 4.0 is intricately linked to the idea of Industry 4.0 which is the sustainable development vision of Germany as discussed in chapter 1 and expanded in chapter 8.

Education 4.0 and Higher Education

James (2019) notes that Education 4.0 is about evolution to keep in pace with what is happening in the world outside education and training. Therefore IHEs (institutions of higher education) must understand what will be expected from their graduates and align their curricula and teaching, learning, and assessment processes to allow for personalised, independent, and appropriate learning paths that will produce 'thinkers, creators and ingenuity' (Agolla 2018:46). 'A revolutionised HE system can produce super humans' (Agolla 2018:46) that will deliver the notable contributions and innovations that will take the global village of the 4IR and Society 5.0 forward. HE curricula must include modules and programmes on the use of technology and the acquisition of hard and soft transferable skills in addition to subject-focused content.

Just when the message of the 4IR seemingly started to get people to work in creative ways to conquer some of the challenges and pin down the ever-shifting goalposts, Covid-19 struck. While the 4IR seems to gain from the pandemic, with more initiatives and inventions appearing on almost every level of living (cf. Schwab & Malleret 2020), education systems were thrown into turmoil or stopped completely in many cases. For decades now, education is extremely slow when it comes to implementing change and transformation (cf. Bates 2010; Passmore 2000). Although the Covid-19 pandemic forcefully pushed the education sector towards transformation and innovation, the shift to blended, online, and digital media platforms for teaching, learning, and assessment cannot be regarded as the paradigm shift that is required to effectively educate societies for the 4IR world. On the one hand, these changes, updates, and solutions should have been made years ago, while on the other hand, these adjustments and modifications can bring a false

sense of accomplishment through which HE can once again slump back into a comfort zone. HE must be reimagined, not restored, as the final evacuation of the ivory tower is unavoidable.

The next decade will be crucial and critical for the future of HE. The full spectrum of blended learning (time, space, media, and activity, cf. Littlejohn & Pegler 2007:75-76) needs to be explored, broadened, and made available to address the needs of individuals, to provide flexible and hybrid forms of learning through 'seamless' connectivity (Hardman 2020).

Internationalisation of Higher Education

Another aspect that can enhance and ensure development in HE is globalisation. Chapters 4 and 5 are furthering the discussion that is introduced here. Altbach and De Wit (2018) indicate that research collaboration on a global scale is increasing. At that stage, there were more than five million international students, specifically in Germany and Canada. However, these figures dissolved within a few months after Covid-19 spread through the globe in 2020. International education will therefore continue to face unpredictable short- and long-term effects.

Currently, IHEs must take the lead in transforming educational key issues (Proctor & Rumbley 2018:4). Within the current disruptive environment, these institutions are required to deliver meaningful contributions to the academic development of both local and international students. Proctor and Rumbley (2018:4) correctly argue that internationalisation has a complex and multi-dimensional nature, finding itself within the international environment of rapid change accompanied by a disruptive environment of social, political, and economic unrest and change. Internationalisation as a more recent development in HE, is presenting established IHEs that did not have any form of global interactions or engagement in their focus, with revolutionary challenges and opportunities to turn their attention to these realities (cf. Proctor & Rumbley 2018).

Knight and De Wit (2018:3) opine that the internationalisation of HE has now 'come of age,' as it is no longer on the periphery of the HE landscape. Nowadays it is imperative for students to acquire an international intercultural competence to work in multicultural societies all over the world. Internationalisation – 'coherently conceived, contextually nuanced, and thoughtfully executed' (Proctor & Rumbley 2018:4) – can supply the competency to graduates to act according to the challenges and innovations of our time.

Although the internationalisation of HE has been, until recently (prior to Covid-19) a priority in the world, there were still many obstacles. Knight and De Wit (2018:3) argue that many countries isolate themselves against it,

while racism and monoculturalism are constantly threatening the initiative. Added to this, IHEs are focusing more on 'people, programmes, providers, policies, and projects,' compared to the process of the internationalisation of HE and research (Knight & De Wit 2018:3). Many IHEs are also still practising internationalisation in fragmented ways (Knight & De Wit 2018:3). Economic and political motivations become key in the process of the internationalisation of HE, while academic and social/cultural rationales are lagging behind. A major threat to the success of the internationalisation process is that its intended purpose of 'cooperation, partnership, exchange, mutual benefits, and capacity building [has been replaced by] competition, commercialization, self-interest, and status building' (Knight & De Wit 2018:4).

International Higher Education in Action: Three Intra-Continental Initiatives in Eurasia

Altbach and De Wit (2018) regards the 25 years between 1990 and 2015 as the 'era of higher education internationalisation.' This includes the movement of students worldwide, the founding of branch campuses and franchises in other countries, as well as joint degrees and the utilising of English as the language of teaching and learning. They argue that this era has 'abruptly ended' due to the hampering policies of the USA (after Trump has been elected as president) and England (after Brexit) on student movements (Altbach & De Wit 2018). Debates on the use of English in countries with other languages (like the Netherlands, Germany, and Italy) are currently thriving.[1]

The international HE initiative by the European Union (EU), is called Erasmus+. This programme is focused on education and training, as well as sport for the youth (Erasmus+ 2020:1 of 25). It assists and motivates the youth to pursue innovative opportunities in education and to empower them with valuable life-skills, complemented by essential international experience (Erasmus+ 2020:4 of 25). It also assists educators to go abroad, sharing and learning innovative ideas, and discovering the most recent best practices (Erasmus+ 2020:6 of 25). Students may even study (and work) outside Europe – in Africa, Asia, and the USA (Erasmus+ 2020:12 of 25). This includes youth exchanges where groups of students, belonging to different countries, come together for a specific time and complete a programme filled with 'workshops, exercises, debates, role-plays, simulations, [and] outdoor activities' (Erasmus+ 2020:13 of 25), designed by their IHEs. The initial life span of this initiative was

1 Altbach and De Wit (2018) list more negative actions taken by nationalist-populist governments, like a branch campus of the Netherlands in Yantai (China) that was cancelled; widely criticised Chinese-funded Confucius Institutes that were founded in Australia and elsewhere; bad behaviour by international students; the increase of visa fees for international students, etc.

from 2014 to 2020 (Erasmus+ 2020:1 of 25). Its aim is the modernisation of education and training of the youth all over Europe, with emphasis on lifelong learning. This programme mostly finances the initiatives of companies all over Europe that meet their requirements.

KIT (Karlsruhe Institute of Technology) in Germany started to collaborate with Arts et Métiers: Le Grand Établissement de Technologie (AeM) in France – both being leaders in, and acting as reference institutes of education, research, and innovation in engineering in Europe (FGI n.d.) – creating the French-German Institute for 'Industry of the future.' For the past 20 years, the two institutes have collaborated in teaching mechanical engineers in a joint degree programme. Their current focus is on 'digitalization [and] advanced manufacturing processes,' preparing European engineers to act as protagonists in the industry of the future, as well as on research and innovation (FGI n.d.). The future challenges that they want to master are globalisation and climate change, together with digitisation, energy transition, and the processing of raw materials (FGI n.d.). Their aims are: 1) To create joint programmes in HE to educate the upcoming workforce and to train engineers to master the challenges of the future manufacturing sector; 2) to create a research and technology platform to facilitate scientific research in both institutions to support the digitisation of both countries' industries; 3) to keep humans at the centre of the industries of tomorrow; 4) to look for industrial partners to accelerate the creation of new products with their obtained knowledge; and 5) to create a cross-border incubator for researchers, academics, and innovative industrial partners in which they want to facilitate and encourage innovation and entrepreneurship (FGI n.d.).

In Southeast Asia, a group of countries – Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam – established ASEAN in 1967 (ASEAN 2015:i). The purpose of ASEAN is to cooperate on a 'political, security, economic and socio-cultural' level with each other, creating a 'single market' trade between these countries (ASEAN 2015:3, 4). Attention is focused to stimulate lifelong learning (ASEAN 2015:4). Their motto is 'One Vision, One Identity, One Community' (ASEAN 2015:29).

These three initiatives are commendable on the level of internationalisation as well as heterogenisation and could set an example for others to follow.

Internationalisation cum or versus Globalisation?[2]

Globalisation can shortly be defined as the 'growing transnational flows, interactions, and connections of people, cultures, economies, and governments' (Saito 2019:198). The globalisation of education is an indication as to how educational networks are growing globally, as well as the processes and IHEs that are affecting educational practices and policies locally (Spring 2014:1). The four 'places' where global discourses are already present, are the 'knowledge economy, lifelong learning, global migration, and brain circulation' (Spring 2014:1).[3]

Globalisation already has a considerable influence on the youth of the world by conveying 'transnational processes' to them, influencing 'ancient barriers' between them like civilisation, nation pride, communities, and even gender, race, and class differences (Cicchelli & Octobre 2019:3). These 'transnational processes' include the innovative technologies presented everywhere, the escalation of the knowledge-based society, and the rise of non-Western powers.

The question is if and how the globalisation process and the internationalisation of HE can be compatible as, to some extent, globalisation has a negative effect on the internationalisation of HE (cf. Cicchelli & Octobre 2019). Saito (2019:197-198) argues that globalisation has a direct impact on students' lives, generating the emergence of both a global youth culture and a global identity, *outside the environment of IHEs* and practices (cf. also Cicchelli & Octobre 2019; Nilan & Feixa 2006). IHEs should therefore adapt to this 'phenomenon' by acting in a way that makes them indispensable in the eyes and development of the students. One way is to legitimise digital literacy as part of all the courses and degrees being presented by IHEs, as this is a crucial subject for 'surviving and thriving in the ICT (information and communications technology)-driven knowledge society' (Saito 2019:200). It should be implemented in a way that is student-friendly and -centred, where students can collaborate with each other on a global basis (Darvin 2019). In this way, IHEs can promote themselves as 'producers of knowledge' and hubs of critical thinking and innovation on an international level (Saito 2019:203-204).

2 The term 'globalisation' was coined by Theodore Levitt in 1983 (Levitt 1983).

3 According to Spring (2014:1-2), quite a few global institutions already influence worldwide educational policies, like the OECD, the World Bank, UNESCO (United Nations educational, Scientific, and Cultural Organization), the WTO (World Trade Organization), and GATS (General Agreement on Trade in Services). Together with that, English is accepted as the global language, being implemented in many schools to prepare the learners for tertiary education (worldwide).

The UN, OECD (Organisation for Economic Cooperation and Development), and the World Bank promote global educational agendas concerning multiculturalism, job preparation, and economic development. NGOs (non-governmental organisations) are already influencing basic education on a global basis, specifically in relation to human rights and environmentalism (Spring 2014:4; OECD 2017). Spring (2014:5) indicates the key terms of the components of educational globalisation: Schools and IHEs should adopt similar curricula, pedagogies, and educational practices and they should conform to the policies of national policymakers. Educational practices on both local and global level should cooperate and be influenced by ICOs (intergovernmental organisations) and NGOs, resulting in the formation of global networks and a global 'flow of ideas.' Multinational corporations should create global curricula, assessments, and other school materials, while HE and its educational services must be marketed and introduced to the entire global village. This includes IT (information technology), e-learning, and the most recent technologies. Research should be done on the effect of world migration on learners and students, becoming part of multiculturalism, including the effect of English as the preferred language of education and commerce worldwide, and the effect of religious as well as indigenous education on visiting students and scholars.

This 'global flow'[4] in education depicts a 'global flow of ideas, practices, institutions, and people interacting with local populations' (Spring 2014:5; cf. Appadurai [1990] 2010:295). The 'educational superstructure' is especially interested in the global flow of ideas and practices with specific reference as to how governments and other international institutions communicate their policies and practices about it (cf. Spring 2014:6) – these are called 'ideoscapes' (Appadurai [1990] 2010:299-300). Nowadays these global flows happen quickly with the support of IT, as educational leaders can meet via a myriad of social communication channels like Skype, Teams, Zoom, Discord, and the like, in this way constructing global networks and attracting more members as time goes by (Spring 2014:6).

Saito (2019:198) indicates a few changes that should take place: As students become more mobile, they should be able to enrol at different universities simultaneously – curricula and pedagogies should therefore adapt likewise, requiring from IHEs to collaborate more with each other on the (re) structuring of degrees (cf. Goren & Yemini 2017). Education and research should thus adapt to these 'isomorphic mechanisms,' like the assessment of international students (Saito 2019:198), evoking IHEs to evolve to institutions where global nation-building can take place (Saito 2019:198; cf. Saito 2011).

4 The term 'global flow' was coined by Arjun Appadurai in 2010 (Appadurai [1990] 2010:301).

Internationalisation and globalisation are not individual enterprises in competition with each other and with the world (cf. Saito 2018). These two initiatives are also not aimed at enriching a specific country or at making sure that one's own IHE becomes the biggest or dominant in the world, but to take hands in a meaningful way to the advantage of all students, businesses, and the global community.

Homogenisation versus Heterogenisation?

Already in 1990, Appadurai referred to cultural homogenisation as '[t]he central problem of today's global interactions' (Appadurai [1990] 2010:295), being a product of globalisation (cf. also Cicchelli & Octobre 2019:3). This results in countries losing their nationalism (Rixey 2019): Cultural homogenisation is all about one (global) culture taking over other countries' cultures. What is mostly referred to, is Americanisation, where this Western culture becomes part of or is enforced on other cultures like those of Africa. Appadurai ([1990] 2010:295) frankly avers: 'One man's imagined community…is another man's political prison.' Many countries are caught up in an existential choice: To retain their own identity, or to adapt to another (Western) identity, therefore slipping into homogeneity (Rixey 2019). This may also happen without countries even knowing it. For example: A specific nation or a group of nations may form an international institution which is joined by other countries in the world, thereby forming a global society. However, that society could appropriate its own ideology/ies (mostly belonging to the founding countries) which are then applied to all the member countries.

On the other hand, cultural heterogenisation refers to a multicultural society. This means that a country's culture is disseminated and accepted by other countries, without giving up their own culture. This is acceptable and within the aims of the International Bill of Human Rights (OHCHR 1948). Looking at this from an educational point of view, heterogenisation is preferable to homogenisation – with specific reference to Africa. Baker and LeTendre (2005:xi) refer to certain schools that continuously benchmark their performance in comparison to international standards, which is a good thing, keeping up with the world without giving up their own identity or culture and tradition.

Global Initiatives, Higher Education Collaboration, and the Way Forward

The book is divided into three sections. The first part is called 'Global Initiatives,' comprising of three chapters, while the second and third parts discuss HE on the level of a collaboration between universities (two chapters), and then the way forward (four chapters).

Many countries have realised that, in order to survive the challenges of the 21st century, they must upscale innovation and initiatives in line with the 4IR. In chapter 1, Willem Oliver refers to some of these important global initiatives and provides an introduction to what is further discussed in chapters 3, 5, and 7. He discusses Industry 4.0 of Germany, extended with the Indo-German industrial collaboration, the Advanced Manufacturing Partnership in the USA, the Industrie du Futur of France, and Made in China 2025. Lastly, he refers to Agenda 2063, an initiative by the African Union for uplifting Africa. Sadly, the abovementioned countries launched their initiatives in isolation, with the aim to benefit themselves, while education, specifically HE does not play an imperative role in most of these initiatives. There could be a twofold reason for this: First, industry and business have realised that HE is lagging so far behind that it will in fact hamper the potential development if involved, and second, in-service training is regarded as having precedence and preference over HE in most cases. Both reasons are devastating for HE and education systems.

Chapter 2 discusses another two initiatives, namely Society 5.0 of Japan and Education 5.0 of Zimbabwe. With Society 5.0, Japan has in mind to transform into a 'super smart society' (GJ 2015:1 of 18). Based to some extent on Industry 4.0 of Germany, the difference between the two initiatives is that Germany's initiative is more product centred, while Japan focuses more on human-centredness (Ferreira & Serpa 2018:26, 28). In this super smart society, HE should be key, together with industry, government, and the broad public (GJ 2015:1 of 18), but the response of education to the 4IR is termed 'slow and inadequate' (Gleason 2018:5), and it 'needs a dramatic realignment' (Aoun 2017:xii).

Education 5.0 of Zimbabwe does not intend to create a new, innovative form of education and was created as a survival kit for a country that is still on its knees due to corruption, 'chaotic and violent' landreform actions, and 'plundering of public resources' (Malunga 2019) after some devastating recent past events. Although reference is made to all the levels of education, the aim of this initiative is to excel this country to a 'competitive, industrialised and modernised nation by 2030' (MHTE 2019:ii), with a link to Education 3.0 and not Education 4.0. It is proposed that the name of the initiative should be changed to avoid confusion.

Chapter 3 discusses the American initiative in more detail, called AMP (the Advanced Manufacturing Partnership), forming 15 advanced manufacturing institutes, and referring to the role of universities within this initiative. William Bonvillian argues that when HE in the USA started to do research on the 4IR, the research was not applied to manufacturing technologies and production, as there was a disconnection between the two sides. As the productivity rate of the USA dropped in the early parts of the second decade of the 21st century,

the country implemented AMP, in which they assigned a leading role to the IHEs. One of the reasons why the productivity rate has dropped, is because the providers of resources, supplies, components, and R&D (research and development) outweighed the departments who had to do the distribution, sales, and repair, skewing the entire manufacturing system.

The big challenge in this regard is still for the IHEs to deliver. That is why the universities have started to work more closely with companies – using manufacturing institute-funded R&D. A college degree has been implemented for economic wellbeing (cf. Golden & Katz 2008), but nowadays it needs to be updated. Currently, the degrees which are presented, do not reflect the career needs and related skills for the 4IR world, and the capabilities taught are not well-tied to competencies needed in the workplace. Once again, it seems as if education is still *lagging*, even in the Global North.

In the second part of the book, we are looking at partnerships between universities, first local and international, and then intra-continental. Exchanging the classroom for a myriad of virtual spaces has prompted educators to rethink the curricula that they were presenting. New curriculum development includes moving content closer to the focus of the 4IR, implementing more scaffolding, making content and learning experiences more student-centred (Ehlers & Kellermann 2019), and assisting students to become self-directed, lifelong learners (Dennis 2020). Having IHEs done this on an individual basis in isolation would take a proverbial lifetime, and therefore Geesje van den Berg focuses on partnerships between IHEs in chapter 4. Participating in two successful partnerships between the University of South Africa (UNISA) and two international universities – the University of Maryland Global College (formerly known as the University of Maryland University College) and the Carl von Ossietzky University of Oldenburg in Germany – she narrates that there is actually 'strength in unity,' more intelligence encapsuled in partnerships, more enhancement in capacity, and more academic development in collaboration (cf. also Van den Berg, Joffe, & Porto 2016). As HE in South Africa was unprepared for the 4IR (Oke & Fernandes 2020), these collaborations assisted UNISA in creating a better educational strategy. A Certificate of Advanced Studies in Online Teaching and Learning at Master's level was offered to UNISA educators. Doing this course, staff members learned how to purposefully integrate technology into their curriculum. An international cohort of scholars were involved as presenters in this programme. All these contributed to getting the staff at UNISA more ready for handling and coping with 4IR demands, thus more ready to partake in this global initiative to get HE on par with the workplace.

Jackline Nyerere from Kenya gives examples in chapter 5 of how specific African academic institutions are working together to meet the needs of internationalisation, globalisation, and the 4IR. Apart from gaining new

knowledge, the students attain intercultural competencies, and bring back much needed scientific knowledge. The mobility of students is therefore encouraged. These issues have been discussed and applied to Africa during a meeting of the AU (African Union) in 2015 where they have decided to launch an initiative called *Agenda 2063: The Africa we want* (African Union Commission 2015). In this meeting the AU emphasised cutting-edge research and innovation, as well as sharing and learning from each other.

A big challenge that Africa faces, is that when its post-graduate students study overseas, they do not return home. This is specifically why East Africa started to encourage students to partake in the intra-regional African mobility, thus studying at another university *inside Africa*. Five countries constitute the EAC (East African Community), namely Burundi, Kenya, Rwanda, Tanzania, and Uganda. Nyerere discusses two IHEs in Kenya, namely the Kenyatta University and the USIU-A (United States International University – Africa). While the mentioned countries' universities focus on sending their students to universities of the EAC, they are also welcoming international students. The USIU-A, for instance, boasts with 15.3% students from various countries abroad, being above the target of 10% set for universities worldwide.

The last part of the book discusses disruptive ways forward for HE. David Ronfeldt and John Arquilla introduce this part, with chapter 6, calling for a rethinking of strategy and statecraft within the 4IR era. They elaborate on the way in which the threats and challenges to societies, institutions, and cultures should be dealt with – on a cognitive level, using an innovative kind of information-age statecraft, called 'noopolitik' – as a successor to 'realpolitik.' Realpolitik is used in 'hard' forms of power by getting an advantage over others, with a good example of Europe's colonisation of Africa. Noopolitik (from the Greek term 'nous' – *mind, thought, reason*), however, has an ideational approach to statecraft with a higher success rate.

This initiative does not leave room for one country to gain power over the other, but rather to create and establish a new way of thinking, an alternative approach to being real citizens of the earth within the 4IR. This way of thinking is slowly but surely 'invading' HE, as there are already quite a few universities and schools presenting programmes in grand strategy. It is rather imperative for curricula to be changed away from realpolitik to noopolitik – moving away from the military, economic, technological, and other geopolitical forces with a view on the past, and start grappling with ideational, cultural, social, and other noopolitical forces of the present and the future.

Joseph Evans Agolla refers to the 4IR as I4R (Industry 4.0 Revolution) in chapter 7, with Industry 4.0 of Germany at the back of his mind. Where Society 5.0 refers to a smart society, he refers to smart products (production), the

smart factory/manufacturing, as well as smart mobility and smart logistics, also in line with Germany's Industry 4.0. He discusses this disruptive trend within an African context. Agolla focuses on the preparedness of Africa and its responses to the I4R and ends his chapter referring to the ways in which Africa can effectively become part of internationalisation and globalisation.

Globalisation has caused education to stop focusing on local curricula and teaching-and-learning methods, and to focus on international knowledge and skills that would make the potential worker fit into any global work environment. Students are therefore motivated and invited to attend international interactive platforms of education – 'virtual classes' – to broaden their knowledge. As today's students are already part of the 'gig economy' (mostly entrepreneurs and freelancers doing short-term jobs, not working for a boss), it is imperative for them to equip themselves maximally with as much knowledge and skills as possible. Education therefore is the main determinant for a nation's competitiveness, adhering to the World Summit on Sustainable Development held in Johannesburg in 2002 (SDG 2002), implying that ESD (education for sustainable development) is imperative for Africa. ESD is meant to shape students socially, economically, morally, and politically, and to prepare them for a job anywhere in the world, being capable to adapt to the fluidity of the I4R.

The way forward for HE within the 4IR is further discussed by Hiro Saito in Chapter 8, reaching the same conclusion as mentioned above, that HE is lagging behind. However, the author points here to a vital situation/danger in which the 4IR is finding itself: Its impact on Earth. From the 1IR onward, technology has contributed to a drastic increase in CO_2 emissions on Earth and in the atmosphere. The result would be that Earth becomes uninhabitable. The WEF has, however, stated that the 4IR will be the first industrial revolution with 'an effective enabling environment' (WEF 2017:4). Will that be possible? Saito argues that HE should first address climate change before it responds to the needed changes for the 4IR (cf. Schwab 2021:145). Curricula should be developed to inform students and the broader public about the consequences of the 4IR on habitable Earth. This is where researchers will play such a vital role in providing the necessary knowledge to the people, indicating that they should not be gullible by postulating that the 4IR only has positive characteristics, over against the modernist positivistic faith in science and technology.

HE and the 4IR are important contributors towards the future of Earth. The theme of climate change, with the issue of geohistorical justice, should therefore be a crucial point on the agenda of HE, as most colonial powers refuse to compensate 'surviving victims of terrible and obvious wrongdoing' (Butt 2015:183). Geopolitical injustice opened the door for political-economic

inequalities and racism, still being rife. The continent that has suffered most from this is most probably Africa.

In the last chapter (9), Ignatius Gous focuses on enhancing learning methods for students. He argues that change in education as well as personal change need to happen more rapidly. However, especially in South Africa, HE is reluctant to become part of a changed environment. It seems as if HE got stuck in the 2IR (Second Industrial Revolution), making the classroom and guiding pedagogies of 2022 look very much the same as the classroom of 1922… or even 1822. This begs the question whether HE was in service of the 3IR (Third Industrial Revolution) at all.

Gous also has the conviction that Covid-19 caused a disruption in education (cf. also Harari 2020). With the commencement of the first wave of lockdowns, learners initially received 'emergency distance education,' but the educators soon realised that it was unsustainable. One reason was that it affected the learning behaviour of the learners. Gous then focuses on effective learning behaviour and narrows it down to *curiosity* – 'information seeking behaviour' – arguing that this kind of behaviour is needed within the world of the 4IR. Whereas curiosity is a common attribute of every person, educators must exploit it maximally to keep their students interested and engaged. In line with the core of the 4IR, education is about the acquisition of relevant knowledge. Because the appropriation of new knowledge happens almost daily, students must be motivated and trained to become self-directed lifelong learners.

According to the WEF (2018), the 4IR is an amalgamation of different technologies that blurs the boundaries between the physical, digital, and biological spheres on Earth. During the first three IRs, education played a vital and pivotal role (cf. Penprase 2018), therefore forming the foundation of transformations taking place in and during these revolutions. However, with the rise of the 4IR, education did not rise to the occasion. Education, and specifically HE, is still stuck within a semi-3IR space. In a sense, Covid-19 came to the rescue, forcing education to use available technologies and innovative resources to survive the lockdowns. Africa proved to itself and the world that this continent can rise to the task. However, the achievements and innovations must be expanded and new pathways explored, preferably by working together as a continent and with the assistance and support from the rest of the world.

Conclusion

The content of this book gives us a glimpse into a few initiatives from around the world and how it interacts with the 4IR. It also shows that HE has not yet come to the party in most cases and that IHEs will have to be creative and

willing to adapt to a *rapid change* mode if it wants HE to be fully part of the 4IR, revolutionary world racing towards a super smart society. With all the in-service training already taking place in big businesses (cf. Schroeder 2016:5) and with the 'gig economy' gaining more ground, HE must take care not to be declared redundant in society. The way forward is for HE to take hands with the 4IR and for IHEs to work together as an example of what can be done when an agenda of sustainable development is put into practice.

Can we successfully combine the 4IR, HE, and global initiatives? Well, the 4IR is described as a blurring of boundaries and a fusion of advances between numerous technologies, creating the perfect storm to pave the way for transformation (McGinnis 2020). This transformation is directly impacting on HE worldwide. Therefore, we as authors hope that the discussions and ideas put forward here, will stimulate, provoke, and create new and exciting ideas and actions that will enhance HE to lead society in positive transformation.

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Global Initiatives

Chapter 1

Global Initiatives within the 4IR, and the Role of Higher Education

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Introduction

As has already been mentioned in the General Introduction, the title of this book is *Global Initiatives and Higher Education in the Fourth Industrial Revolution*. The way in which the book approaches this title, is to first discuss the different economic initiatives – focused on manufacturing – developed by specific countries to meet the 4IR (Fourth Industrial Revolution) and to critically look at the role of HE (higher education) within these initiatives. One could argue that HE should be key in this new era, as it powerfully shapes the lives of specifically the younger segment of our people with reference to their aspirations, their beliefs, and their identities, focusing on their skills and future livelihoods (Saito 2019:197). The 4IR naturally forms part of these discussions. Specific attention is also given to Africa and the role that this continent should play with regards to HE and/in the 4IR (cf. Marwala 2020), as seen in chapters 4, 5, 7, and 9.

The 4IR has taken (or is taking) the world by storm with, *inter alia*, AI (artificial intelligence),[1] IoT (the internet of things),[2] IIoT (the industrial internet of things),[3] CC (cloud computing),[4] CPS (cyber-physical systems),[5]

1 For more information on AI, cf. Rouse (2020), as well as Chalmers, MacKenzie, and Carter (2021).
2 For more information on IoT, cf. Burgess (2018), Agolla (2018), and Ranger (2020).
3 For more information on IIoT, cf. Schmid (2018).
4 For more information on CC, cf. Tutorialspoint.com. (n.d.).
5 For more information on CPS, cf. Agolla (2018) as well as Ferreira and Serpa (2018).

robotics (advanced robots and co-robots),[6] AR (augmented reality),[7] IoE (the internet of everything),[8] IoS (the internet of services),[9] HVI (horizontal and vertical integration),[10] and BDA (big data analytics),[11] coupled with IoD (the internet of data)[12] being rolled out, in which digital transformation[13] acts as common denominator (Fukuyama 2018:47). In order to meet the demands of this new era, countries all over the world are developing and implementing economic and industrial programmes or plans, also called initiatives. Examples of these initiatives are (chronologically) I4.0 (Industry 4.0, developed in 2011 by Germany), AMP (Advanced Manufacturing Partnership, launched in 2011 by the USA), S5.0 (Society 5.0, developed in 2015 by Japan – cf. Gladden 2019), IdF (Industrie du Futur – *Industry of the Future*, France 2015), Agenda 2063 (Africa's plan – cf. AU 2015), MIC 2025 (Made in China 2025 – also developed in 2015), and Zimbabwe's E5.0 (Education 5.0, developed in 2019).[14]

From an educational perspective, one could argue that these initiatives would be requiring a cohort of professionals who are equipped with knowledge and the expertise to drive the programmes. To realise these goals, excellent (primary, secondary, and higher) education should be a condition to produce excellent/smart experts. Without the necessary education, it would seem to be impossible to reach the level of performance or expertise required from someone to partake in these new initiatives. However, although these initiatives are very high-tech and well explained, also (mostly) with reference to collaboration (not on equal level though) with other countries or 'the world,' education, specifically HE seemingly does not really get the attention that it should – the industry and other technological commodities take priority over HE, as indicated below. While some of these initiatives do not even explicitly

6 For more information on robotics, cf. Dzedzickis, Subačiūtė-Žemaitienė, Šutinys, Samukaitė-Bubnienė, and Bučinskas (2022), as well as Sirlantzis, Larsen, Kanumuru, and Oprea (2019).
7 For more information on AR, cf. Chen, Wang, Chen, Song, Tang, and Tian (2019).
8 For more information on IoE, cf. Banafa (2016).
9 For more information on IoS, cf. Agolla (2018).
10 For more information on HVI, cf. Sewak & Vaidya (2022).
11 For more information on BDA, cf. Rai (2019).
12 For more information on IoD, cf. Agolla (2018).
13 For more information on digital transformation, cf. Boulton (2019).
14 Apart from these initiatives, many other countries in the world also have plans/strategies/initiatives, like Australia 2056 (Reinvent Australia 2016), England's High Value manufacturing Strategy (TSB 2012), the United Arab Emirates with Vision 2021 (UAE n.d.) and the 2030 Agenda for Sustainable Development (NCSDG 2018), Russia in the 21st century (ICD 2010), and the National Vision 2030 of Qatar (GSDP 2008), while South Korea does not have any formal document stating a strategy, but some scholars have deliberated on the development of this country (cf. Chung 2011; Cooke 2017; Hemmert 2007; Kim & Kim 2018; Seong, Popper, & Zheng 2005).

touch on HE, Japan's S5.0 refers continually to collaboration between the corporate sector, government, and HE (GJ 2016), elaborating extensively on the tasks of the first two sectors, and often only implicitly on the latter.

It is common knowledge that education, and for that matter HE, globally does not yet meet the expectations of the corporate world entering the 4IR – according to the government of Japan it was *lagging behind* in 2015 (GJ 2015:6) – currently it still is (Atlason 2020; Jadoul 2021). Fact is that every country has its own standards for education, which obviously differ from those of other countries. Fact is also that no country is an isolated entity. Especially in this new era, collaboration within the various HE systems in our global village is of utmost importance to achieve excellence. However, Chamorro-Premuzic and Frankiewicz (2019a) aver that 'it is hard to argue that the knowledge acquisition historically associated with a university degree is still relevant.' They add that 'meta-analytic reviews have long-established that the correlation between education level and job performance is weak' (Chamorro-Premuzic & Frankiewicz 2019a). This is an indication of why HE is neglected in the workplace.

Already in 2015, the UN (United Nations) issued an *Agenda for Sustainable Development* (UN 2015), containing their SDGs (ssustainable development goals) for 2030, challenging *all nations to work together* in order to reach a sustainable world with reference to and in service of economic development (Fukuyama 2018:47). With these goals at the back of our minds,[15] this book wants to look deeper into the role and requirements of HE in this new era, with specific reference to and collaboration between the abovementioned initiatives, and also the role that Africa can play in it – alternatively, the role that it will play in Africa. However, would it be possible to establish a way of cooperation between these initiatives, complementing each other, and taking 'the world' to a new level in a very short time by means of internationalisation. Currently, it seems to be impossible.

This chapter will shortly discuss the abovementioned initiatives (excluding S5.0 and E5.0) and the role that they are currently playing. Connected to this chapter, is chapter 2 that discusses S5.0 and E5.0 within

15 This Agenda was set, definitely well-knowing of Germany's I4.0 and the USA's AMP, but with no reference to one of these two initiatives. This 'plan of action' has the 'people,' the 'planet,' and 'prosperity' in mind, aiming at the eradication of extreme poverty, and to 'heal and secure' the planet (UN 2015:3). A positive tendency in this Agenda is that the UN called on all countries in the world to take part in a collaborative partnership, strengthening global solidarity (UN 2015:4). Although there are references to education, the betterment of education and specifically HE was not on the Agenda. Technology, with all its components, is also not highly ranked on the Agenda. This Agenda will therefore not form part of the discussions in this chapter.

their contexts and the role that HE plays in these two initiatives. In this chapter then, the mentioned initiatives are discussed, with a cursory look at the role of HE in these endeavours.

Industry 4.0

I4.0 was developed by Germany in 2011, being preceded by Deutschland Digital 2015, which was introduced in 2010 by the BMWi (Bundesministerium für Wirschaft und Energie – Federal Ministry of Economic Affairs and Energy; Horst & Santiago 2018:6). Schroeder (2016:1, 6) refers to this initiative as an evolutionary – and not a revolutionary[16] – enhancement of the production and business model. According to Rojko, it is no surprise that Germany made this innovative move, as this country can be regarded as a world leader in the sector of manufacturing equipment, being 'the world's leading user and provider of digitalised production technologies' (Schroeder 2016:0)[17] with a view of establishing a global I4.0 landscape (Schroeder 2016:6; cf. also Horst & Santiago 2018:vi). Holtkamp and Iyer (2017:Executive Summary, 1) boldly identify the I4.0 initiative with the 4IR, 'a mega-trend that affects every company around the world.' Their reference to the mega-trend may be correct, but there seems to be a significant difference between I4.0 (a local initiative as part of the 4IR) and the 4IR itself, which is a global trend.

Germany developed this initiative to stay 'one of the most influential countries in machinery and automotive manufacturing' (Rojko 2017:80). To assure that they stay there, they have also put PI4.0 (Plattform Industry 4.0) in place in 2013 (DKE 2018:12; cf. also Staufen & Staufen 2018) – 'one of the most emblematic instruments of the strategy' (Horst & Santiago 2018:2; cf. 23-27).[18] PI4.0 consists of professionals representing 'the business sector, the scientific sector, trade unions, politics and consumer groups, [focusing on standardisation,] research and innovation, the security of networked systems, the legal frameworks, and employment and (further) training' (DKE 2018:12). Education and training form one of their working groups (Horst & Santiago 2018:26).

According to Popławski and Kajczuk (2019:24 of 78), I4.0 has three challenges with reference to the 4IR: First, it is expected from the producers

16 With this, Schroeder contrasts I4.0 to the US model which he negatively refers to as 'revolutionary' (Schroeder 2016:1).

17 This is the page before page 1 in the author's 'book,' not being numbered.

18 PI4.0 was created by BITKOM (Bundesverband Informationswirtschaft, Telekommunikation und Neue Medien – German/Federal Association for Information Technology, Telecommunications, and New Media), VDMA (Verband Deutscher Maschinen- und Anlagenbauer – Mechanical Engineering Industry Association), and ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie – Association of the Electro-Technical and Electronic Industries).

to change their existing business models to fit the 4IR and to stay on par with new competitors in the market; second, SMEs (small and medium enterprises) will have to increase their capability to produce software that would be able to link their products to digital technologies; and third, with the 4IR, external producers of software posing a threat to the German products, gaining digital sovereignty over Germany, should motivate the German manufacturers to create better software.

The main idea of I4.0 is to develop the potential of the most recent technologies like IoT,[19] the incorporation of 'technical processes and business processes [in companies,] digital mapping and virtualization of the real world,' and the establishing of the 'smart' factory (production system) and 'smart' products (Rojko 2017:80). Fuchs (2018:281) adds that it propagates a 'combination of [IoT,] big data, social media, cloud computing, sensors, [AI,] robotics, and the application of the combination of these technologies to the production, distribution and use of physical goods.' This results in smart factories[20] complemented by smart products, where the tools and machines are automated (Horst & Santiago 2018:3-4). The implication is that these smart products have embedded sensorics showing their appointed destiny, their product state/status and their environmental conditions. These products are able to 'control their logistical path through the production [process] and even control/optimize the production workflow that concerns them' (Rojko 2017:82). This includes production robots and transportation devices. Therefore, both the '*means* of production and the *product* itself' are fitted with sensors and actuators, which connect the one with the other (Rojko 2017:82; original emphasis). This is called a CPS/CPPS (cyber-physical [production] system) – an integration as well as a communication and cooperation between technology, virtual space, and human beings (called 'super human capital' by Agolla 2018:41), connecting the real and virtual worlds with each other, and constituting a real collaborative network (Ferreira & Serpa 2018:27; cf. Hennies & Raudjärv 2015; Rubio-Tamayo, Gertrudix Barrio, & García García 2017), with M2MI (man to machine interaction) and M2M (machine to machine) communication (Agolla 2018). The way in which these are connected, is called the IoT or IIoT – collaborating by means of cloud computing (Ang, Goh, Saldivar, & Li 2017:4 of 13; Agolla 2018:42-43). In this way, every item can directly be located and kept track of in the production and supply chain.

This will definitely have an influence on 'training and study programmes' in the country (Schroeder 2016:5; cf. Ittermann & Niehaus 2015). At this stage,

19 For more information on IoT, with specific reference to I4.0, cf. Ito, Abd Rahman, Mohamad, Abd Rahman, and Salleh (2020).

20 Horst and Santiago (2018:3) refer to it as digital factories.

the training and further study needed, seemingly do not partner much with HE, as the workplace rather utilises in-service training (Schroeder 2016:5). Ferreira and Serpa (2018:27) argue that, if I4.0 really wants innovation to occur, education and training only in technology would not suffice, as 'both individual and organisational learning for change and flexibility are essential' (cf. also De Abreu 2018; Rotatori, Jeong, & Sleeva 2021). Germany has, however, decided to improve its educational system in order to adapt to the standards of the 4IR and the global competition in education (Popławski & Kajczuk 2019:33 of 78), especially because the developing countries' education levels are rising exponentially.

Although the previous paragraph does not paint a good picture of the utilisation of HE in the workplace of I4.0, Huk positivistically links Education 4.0 to I4.0, stating that the latter lays 'the foundations for modern education' (Huk 2021:40). He builds his argument on the fact that one of I4.0's main challenges is the 'sustainable development in productive processes' (Huk 2021:40; cf. Paravizo, Chaim, Braatz, Muschard, & Rozenfeld 2018) and how to integrate these processes with the digital media (cf. Dalenogare, Benitez, Ayala, & Frank 2018). This results (should result) into a higher productivity efficiency with relation to time and resources (Coşkun, Kayıkcı, & Gençay 2019). The transformation of education in general should therefore be in accordance with I4.0, 'resulting from deeper symbiotic, including emotional, interaction between a human being and a machine' (Huk 2021:40).

Despite all these positives, Fuchs notes ten reasons why he is sceptical about I4.0 (cf. Fuchs 2018:284-287). These reasons are mostly about the technology and workers who will have to work with AI and are in fact not ready or capable to do so. However, nothing is mentioned of the lack of interest in HE in the implementation and the unrolling of I4.0.

The Indo-German Industrial Collaboration[21]

According to Holtkamp and Iyer (2017:Executive Summary), Germany and India have a 'long history of trade' – however, no dates are indicated. This has led to the IGCC (Indo-German Chamber of Commerce) which is to date (according to Holtkamp & Iyer 2017:Executive Summary), the largest global chamber, situated in both India and Germany. This initiative gave rise to Make in India, which was launched in 2014 (MIIM n.d.). At the Hannover Messe 2015,

21 According to Horst and Santiago (2018:1), German industries also partnered with Japan, France, Italy, Australia, and Czechia, and also had a strong influence on Made in China 2025. They also refer to partnerships with Brazil, Egypt, India, Kazakhstan, Mexico, Malaysia, Thailand, and Viet Nam (sic.) (Horst & Santiago 2018:1). Amidst this collaboration, India also has its own goals set for itself, like Strategy for India @ 75 (NITI Aayog 2018), aimed at 2022, when India celebrates its 75th commemoration of freedom.

the largest industrial fair in the world, India became a partner of Germany (Make in India n.d.). India then saw potential in the Mittelstand (middle-class) companies in Germany[22] and implemented MIIM (Make in India Mittelstand!), preparing the way for these companies to enter the Indian market (cf. Nair & Von Laer 2017).

The collaboration between Germany and India, with reference to I4.0, is on the level of economics and society, involving 'industry, government, and academics' (Holtkamp & Iyer 2017:Executive Summary).[23] Germany is regarded as a global leader in manufacturing and technology but, according to Holtkamp and Iyer (2017:Executive Summary), its IT (information technology) sector somehow falls short. Fortunately, India is regarded as having a leading position in the world on the level of IT and its outsourcing of business processes (Holtkamp & Iyer 2017:Executive Summary). On a technical level, I4.0 is considered from both a vertical and a horizontal level of integration: The vertical integration concerns the operations taking place in the 'smart factories,' whereas the horizontal integration refers to 'smart supply chains' being developed between businesses in both countries.

This initiative is hopefully one of a few that could spread to a worldwide collaboration between countries. However, HE is net even mentioned in this endeavour.

Advanced Manufacturing Partnership

AMP (being more elaborately discussed in chapter 3) was launched in 2011 by the government of the USA, as a national endeavour to bring about a closer collaboration between their industries, HE, and the government in order to boost emerging technologies in the country and to create better jobs and job opportunities – all of these would enhance their global competitiveness (The White House 2011; cf. Bonvillian & Singer 2017). They therefore needed to advance their technologies (*inter alia* information technology, biotechnology, and nanotechnology) to create more and better jobs.[24] By

22 Mittelstand companies are the pillars of the industry and economy in Germany. These companies are mostly family owned and small in comparison to the large companies in the country. However, these companies have cutting-edge technologies at their disposal and can be regarded as market leaders with reference to the products that they produce (MIIM n.d.).

23 The two German institutions that are operative in assisting with this process, are DAAD (Deutscher Akademischer Austauschdienst – the German Academic Exchange Service) and DWIH (Deutsche Wissenschafts- und Innovationshäuser – the German House for Research and Innovation).

24 However, according to Bonvillian and Singer (2017:4), some 'legacy economic sectors' are resisting innovation, including the manufacturing sector, fossil fuel energy, the electricity sector, health care, transport – specifically highway

doing this, they would help their manufacturers to reduce production costs, to improve quality, and to accelerate product development (The White House 2011). The aim of this initiative is to build

> domestic manufacturing capabilities in critical national security industries; reducing the time needed to make advanced materials used in manufacturing products; establishing U.S. leadership in next-generation robotics; increasing the energy efficiency of manufacturing processes; and developing new technologies that will dramatically reduce the time required to design, build, and test manufactured goods (The White House 2011).

Five basic models were identified to drive the innovation, namely 'the innovation pipeline,[25] induced innovation, the extended pipeline, manufacturing-led innovations, and innovation organization' (Bonvillian & Singer 2017:7). AMP was established on three pillars: 1) The enabling of innovation; 2) to secure the talent pipeline; and 3) to improve the business climate (PCAST Meeting 2014:4 of 12).

Reference is made to 'leading universities' and companies[26] that would be role players to reach these cutting-edge technologies. It is important to note that the IHEs (institutions of higher education) – initially these were the Carnegie Mellon University, Stanford University, University of Michigan, University of California-Berkeley, Georgia Institute of Technology, and Massachusetts Institute of Technology – committed themselves to collaborate on a multi-university level to share their educational materials along with their best practices concerning innovation and advanced manufacturing. These institutions also involved industry partners as well as prominent government agencies to find and create research opportunities (The White House 2011). This initiative was set to be a local initiative in competition with the world. In 2014, President Barak Obama invited the private sector, the IHEs, and government to collaborate in manufacturing and developing cutting-edge

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transport – and agriculture. GAO (2019:1 of 71) states that this has happened from the turn of the century onward.

25 Bonvillian and Singer (2017:7) refer to this model as a 'pipeline model,' stating that it has dominated the thinking pattern of science and technology in the USA. The implication is that research (invention and innovation) was dumped into the pipeline, expecting the industry to create miracles inside the pipe, and then new products would emerge at the other end. However, the private sector has invented another mode, called 'induced innovation,' where a specific company identifies a gap in the market, and fills it with a 'technology advance.'

26 The manufacturers who were initially involved, are Allegheny Technologies, Caterpillar, Corning, Dow Chemical, Ford, Honeywell, Intel, Johnson and Johnson, Northrop Grumman, Procter and Gamble, and Stryker.

technology tools in order to *compete* with other countries in the world. He motivated these sectors to be autonomous and independent of the rest of the world by inventing their own products and manufacturing it themselves. This would be key to delivering high-quality products and good jobs for all the Americans (The White House 2011; Molnar 2012). This statement paved the way for the government's statement in 2014: 'The U.S. has been the leading producer of manufactured goods for more than 100 years' (PCAST Meeting 2014:2 of 12).

From a German point of view, Schroeder (2016:0, 1) refers to this initiative – obviously with I4.0 in mind, and in a negative sense – as a 'disruptive US model…[with the] potential to crowd out existing production and business models.'

The Industrial Internet of Things

IIoT has been introduced by the GE (General Electric) company in the USA in 2012, referred to by Holtkamp and Iyer (2017:7) as the 'Industrial Internet Initiative.' They regard it as a 'tight integration' of digital innovations and the physical world in order to combine BDA with the IoT (Rojko 2017:78). GE calculated that 46% of the global economy could benefit from this initiative (Rojko 2017:78). According to Rojko (2017:80), the 4IR was instigated by this development of ICT (information and communications technology) with the smart mechanisation of cyber-physical systems as its technological basis, coupled with IoT functionalities. The effect that this initiative would have on the industry, was the innovation and reorganisation of the old ways in which mechanisation was done, which would result in a 'self-organizing cyber physical production system that allows flexible mass custom production and flexibility in production quantity' (Rojko 2017:80). HE was not mentioned here as it apparently did not form part of the focus of this endeavour.

Industrie du Futur

With a commitment towards the UN SDGs – specifically 'SDG9: Industry, Innovation and Infrastructure' (GMIS 2018:9), the French government launched IdF in 2015 as part of their industrial policy (cf. EC 2017; AIdF 2018:3). This was a collaboration between industry and science, 'as an overarching plan and roadmap for industrial renewal' (EC 2017:3). The French strategy, NFI (La Nouvelle France Industrielle – New Industrial France; GRF n.d.) preceded the IdF and was launched by the French government in September 2013. The first phase – NFI – was developed by the National Council for Industry, with contributions by the McKinsey Consultancy, in which they have selected 34 industrial plans. This was the result of a groundbreaking analysis of the growth markets in the world, linked with developments on the level of digitisation

and the industry (EC 2017:5). IdF launched French Fab in 2017, which was a new Made in France initiative with the aim to market French manufacturing globally (GMIS 2018:10).

IdF is established on five pillars (EC 2017:3; GRF 2015:9 of 55). The first pillar is the development of cutting-edge technologies, including IoT and augmented reality. To reach this goal, the French government started to support companies in France with research funding, as well as subsidies and loans. They have also created 'a network of platforms' to test all the new technologies (EC 2017:3; GRF 2015:10 of 55). The second pillar is assistance given to smaller French companies to adapt to new technologies and to engage in projects (GRF 2015:11 of 55). The third pillar concerns the intensive training of employees – 'upskilling the workforce [by] developing training programmes and curricula' (EC 2017:3; cf. GRF 2015:12 of 55). The fourth pillar is collaboration on an international level, focused on industrial standards and alliances (GRF 2015:12 of 55). In this concern they entered into a bilateral cooperation with Germany (I4.0). The fifth pillar is to promote the French industry globally by means of high-quality projects with the 'Creative France Industry' brand on it (EC 2017:3; GRF 2015:13 of 55).

The aim of IdF is mostly threefold: To assist companies in their deployment of digital technologies, to change specific company and business models, and to modernise the production practices of companies (EC 2017:3). This is a collaboration between the government, industry, technology and research stakeholders, and trade unions in order to launch 'a network structure to support digital transformation…where [a] modernisation of production tools and a transformation of business models [are]…required' (EC 2017:3). The objective of IdF is to revolutionise their products in such a way that these products would be wanted globally. Key in this regard is to help France become a leader in the world economy and industrial renewal (EC 2017:3).

Nine thematic areas for industry renewal have been identified, against the backdrop of a 4IR thinking (GRF 2015:18 of 55):

1. *New resources* (eco-industries and chemicals – materials, extractive industries, and primary processing): With this, the government has in mind to provide 'new bio-based and recycled materials' to all their industries (GRF 2015:21 of 55), in this way looking for 'more efficient and more ecological ways of producing [and the d]ouble use of plant-based raw materials in the chemicals industry in France' (GRF 2015:22 of 55).

2. *Smart cities* (eco-industries): The government wants 'resource-efficient cities, from producer to consumer' (GRF 2015:25 of 55).

3. *Eco-mobility* (automobile industry): A cheaper, 'greener, safer mobility [is needed], offering the widest possible range of options [with] vehicles [that are] more economical, more connected and more autonomous to meet…user expectations' (GRF 2015:29 of 55). They obviously have electric vehicles in mind.

4. *Tomorrow's transport* (aerospace, rail, and naval transport for people and goods): Electrification of all their means of transport is tops on their priority list, including a high-speed train and 'ships of tomorrow' (GRF 2015:33 of 55).

5. *Medicine of the future* (more effective healthcare): The government has in mind to deliver low-cost top quality healthcare (GRF 2015:37 of 55).

6. *The data economy*: Digital technologies like smartphones, tablets, computers, laptops, and IoT contain vast quantities of data. These data act as a source of value for the users, which need to be utilised in order to guarantee growth in this sector (GRF 2015:41 of 55).

7. *Smart devices* (digital and consumer goods): This is all about IoT, which should be utilised to enhance everyday life. It includes the production of robots and better smart devices (GRF 2015:45 of 55).

8. *Digital confidence*: This includes a better security system on digital devices for both individuals and companies (GRF 2015:49 of 55).

9. *Smart food choices*: With this, the government has a safer, 'healthier, more sustainable food production with greater export potential' in mind (GRF 2015:53 of 55).

According to the European Commission, each one of these nine areas has its own objectives, time of implementation, and marketing (EC 2017:5). In this manner, IdF wants to be part of the leading countries on the level of production and industry in the world. As has been shown in this section, education, and specifically HE, is almost not mentioned. There could be one of two reasons for this: First, that it is implicated (*obvious*), and second, that the 'training programmes and curricula' mentioned above, are efficient enough for their workers (EC 2017:3).

Made in China 2025

On 8 May 2015, China developed their initiative called Made in China 2025, which started off as a collaboration between the China Ministry of Industry and Information Technology and experts from the China Academy of Engineering

(Rojko 2017:78; Ma, Wu, Yan, Huang, Wu, Xiong, & Zhang 2018). This was regarded as a 'ten-year, comprehensive blueprint' (USCC 2017:6 of 80) to 'transform China from a manufacturing giant into a world manufacturing power' (Ma *et al.* 2018:3; cf. State Council 2015), with the main focus on manufacturing. The reason is given by the State Council (2015) of China: 'Manufacturing is the main pillar of the national economy, the foundation of the country, tool of transformation and basis of prosperity.'

The Institute for Security & Development Policy (2018:2 of 9) states that the I4.0 of Germany and S5.0 of Japan played a major role in the development and creation of MIC 2025 (cf. OECD 2017). Wübbeke, Meissner, Zenglein, Ives, and Conrad (2016:6 of 73) refer to it as 'smart manufacturing.'

10 strategic industries were targeted, including 'next generation information technology, aviation, rail, new energy vehicles, and agricultural machinery' (USCC 2017:6 of 80). This initiative proposed a 'three-step strategy,' consisting of the following: First, China needs to grow into being a manufacturing power as soon as 2025; second, by 2035, this country wants to reach the 'medium level' of manufacturers in the world; and third, China wants to reach the top list of world manufacturers by 2049 (Ma *et al.* 2018:3-4). This would coincide with the 100th anniversary of an independent PRC (People's Republic of China) (Morrison 2019:1; CBBC n.d.:4). Rojko (2017:78) agrees that China has in mind to move and renovate its manufacturing industry from delivering low-cost products to delivering products with high quality. The aim is to outdo the dominance of Germany and Japan by 2035 and to become a superpower by 2049.

To reach their goal, the government has pointed out and prioritised nine tasks: 1) The improvement and innovation of the manufacturing sector; 2) the integration of IT and industry; 3) the consolidation of the industry; 4) the marketing of Chinese brands; 5) the enforcement of the renewal of production processes to diminish its impact on the environment, called green manufacturing; 6) the innovation of key sectors in the industry, like IT, robotics, better equipment to enter space as well as the oceans, and energy-saving vehicles using new forms of energy; 7) to restructure the manufacturing sector as a matter of priority; 8) to promote industries which are service-oriented and manufacturing-related; and 9) to internationalise their whole manufacturing business (Ma *et al.* 2018:3-4).

According to Phillips, the Chief Executive of the CBBC (China-Britain Business Council), this initiative is very ambitious and aims at the comprehensive upgrading, consolidating, and balancing of the entire manufacturing industry of China (CBBC n.d.:3). The CBBC adds that there is a direct link between this initiative and the Chinese Dream, which focuses on a long-term reform of the Chinese society to harmony and

prosperity. This co-exists with the fact that China's manufacturing was on the decline, amidst an 'oversupply in some industries' (CBBC n.d.:3).

However, not everybody is happy with this initiative, especially not the USA. Looking at MIC 2025, the USA criticises the initiative as distressing not only for its own domestic economy but also for that of their economic partners (USCC 2017:7 of 80). Morrison (2019:1) explicates it, stating that China's evolution to a free market economy is in direct opposition with the USA. With their expanded role in the economic system, there is a possibility that they could distort the global markets including those of the USA. The Trump Administration has included MIC 2025 in their Section 301 actions that they are planning against China. In Section 301, the Administration postulates that MIC 2025 depicts distortive policies with reference to 'technology transfer, intellectual property, and innovation' (Morrison 2019:1). They also allege that China, who only assembled products locally, now wants to also invent these products locally before assembling them.[27] On 15 June 2018, Lighthizer (from the Executive Office of the President of the USA; Lighthizer, 2018) has put it bluntly that the China government is determined to undermine the industry of the USA, and wants to take over the leadership role 'through unfair trade practices and industrial policies' like MIC 2025 (Morrison 2019:1). China took notice of these 'hostilities' and hit back, stating that they are aware of the resentment of the EU, Germany, and the USA towards their initiatives, as this would transform them from being a low-cost manufacturer to a manufacturer with added-value competition (ISDP 2018:1 of 9). Already in 2005, their neighbour, South Korea had concerns about 'a rising China,' as clarified in a report of the Korea Institute of Science and Technology, Evaluation and Planning (Seong, Popper, & Zheng 2005:7). Again, no real mention of HE is made, as the focus is on employees who have to do blue-collar work, not needing any certificate, diploma, or degree.

Agenda 2063

This plan differs from the abovementioned initiatives as it mostly does not have the wellbeing or collaboration of other countries or states in mind. It contains a 50-year plan *by* Africa *for* Africa, continuing the 'pan-African drive over centuries for unity, self-determination, freedom, progress and collective prosperity, pursued under *Pan-Africanism* and *African* Renaissance…and seeks to accelerate the implementation of past and existing continental

27 This is based on and confirmed by a statement made by the Policy of the Institute for Security & Development of China (ISDP 2018:1 of 9), 'The aim is to reduce China's reliance on foreign technology imports and invest heavily in its own innovations in order to create Chinese companies that can compete both domestically and globally.'

initiatives for growth and sustainable development [with emphasis on] an *integrated, prosperous and peaceful Africa*' (AU 2015:2 of 20; original emphasis; cf. AU 2019). This plan must be driven by Africa's own citizens, in this way representing a dynamic force globally. It is focused on a 'development and technological process' (AU 2015:2 of 20; cf. AU 2019) and does not really mention much related to education. It is therefore more concentrating on an internal collaboration between the countries on the continent, than on anything else.

The plan is divided into five 10-year plans, consisting of 12 flagship projects, including both a pan-African E-university and a pan-African virtual university. According to Agenda 2063, both these universities, especially the latter one, are more focused on African students. There is, however, no time schedule for establishing these universities. Currently there are already universities in Africa with international students, specifically in Kenia (cf. chapter 5). Under the heading 'highlights of a few other programmes,' the fourth item refers to 'expanded early childhood education and compulsory secondary education,' but without elaborating on it (AU 2015:13 of 20). The roll-out of Education 5 by Zimbabwe, which is in line with this item, will be discussed in chapter 2.

The plan is linked to the UN SDGs 1, 2, 3, 4, 6, 7, 8, 9, 11, 13, 14, 15, and 16, with 20 specific goals. That includes, *inter alia*, a high standard of living, well-educated, well-skilled, and well-nourished citizens, transformed economies, modern agriculture, the foundation of an African financial and monetary institution, establishing Africa as a major partner in global affairs, and a united Africa (AU n.d.).

With Agenda 2063, Africa aims to take 'charge of its global narrative to ensure that it reflects continental realities, aspirations and priorities and Africa's position in the world' (AU 2015:18 of 20).

The Initiatives Revisited

This heading acts as a critical note on the absence of a focused HE within the current mentioned world markets and initiatives (cf. Teo, Unwin, Scherer, & Gardiner 2021; Li, Nosheen, Ul Haq, & Gao 2021). Fact is that all the countries in the world have one common goal, which is to generate money. To reach that goal, the industry and manufacturing sector must perform in order to create not only a local market, but a global one.

I4.0 has in mind to create and launch a global I4.0 landscape (Schroeder 2016:6). This does not mean that 'all the countries in the world' will partake in this initiative and become part of it as partners, but that they may link and engage with the initiative by using the products and knowledge created by I4.0. The 'copyright' and honours will stay with Germany. Really commendable

is the Indo-German industrial collaboration where the two countries are working together to a common goal, but each with its own (copyrighted) contribution. The introductory chapter has already discussed the French-German connection, specifically on an educational level. This is really the way forward and should be done on a global scale. France and Germany also have a bilateral cooperation on the level of trade and industry, dating back to as early as 1963 (cf. FFO 2020).

With the launch of AMP, it was clear that this was a local initiative aiming at creating jobs and making the USA more competitive in the global village (Bonvillian & Singer 2017), also becoming the world leader in next-generation robotics (The White House 2011). The launch of IIoT by the GE company would add to that.

The fourth and fifth pillars of IdF of France are linked with a seemingly hidden agenda. Whereas the former refers to collaboration on an international level (cf. GRF 2015:12 of 55), the latter depicts France as becoming a 'leader in the world's industrial renewal' (EC 2017:3). To the credit of France, it must be said that its initiative, which is also very local, is not overwhelmingly competitive of nature like the abovementioned initiatives.

China was not secretive when its state council announced that, with MIC 2025, this country wants to 'transform China from a manufacturing giant into a world manufacturing power' (State Council 2015). Collaboration with China would be possible, but also not on an equal basis. According to Amadeo, the president of WorldMoneyWatch, this initiative has led to China being the world's largest economy in 2020, for a fourth consecutive year (Amadeo 2020).[28] The way in which China executed its plan, attracted much criticism from countries like the USA.

There is nothing wrong with countries aiming to create means to generate money. However, instead of collaboration between countries on a global scale, the buzzword is mostly 'competition.' Countries are rather trying to become totally self-reliant, like the USA and China, than to work together with other countries for the good of both of them and of the world. Further, instead of claiming that *the world* has discovered or invented something like AI or big data, the viewpoint is always that it *must* be ascribed to a specific country and most of the time, to an individual or group in that country. Collaboration between countries takes place but mostly on an unequal basis.

The one notion that is close to being totally ignored in all the initiatives mentioned here, is HE. The impression is that secondary education is good enough, being complemented with in-service training in the sector where a

28 She bases her argument on the fact that China's figures in relation to PPP (purchasing power parity) – which relates the exchange rate between currencies to consumer price levels – are better than that of the USA.

person works. The reason for this can be twofold: 1) HE is not up to standard to meet the expectations of the 4IR, or 2) HE is regarded as redundant and is replaced with in-service training. For many low- to middle-standard jobs, this could be acceptable, but the moment that we talk about jobs requiring real intellectual skills and expertise, jobs where innovation and new inventions are expected, then HE should be imperative and act as a prerequisite. The question, however, is whether HE – inside the 4IR – can live up to the standards of the industrial world.

Then there is Africa. This continent is still suffering from a 'postcolonial disorder'[29] (Oliver & Oliver 2019:53). This disorder eventually became a culture whereby the natives of Africa are still living. Africa is still struggling to rid that culture. This is the reason why the continent's plan, as indicated above, is more inclusive by nature, with more focus on tradition than on HE. Agenda 2063 is therefore a constructive attempt to bring this continent back in the world arena, and should be commended for that reason.

Conclusion

We have discussed five initiatives in the world, namely I4.0 of Germany, enhanced by the Indo-German Industrial Collaboration, AMP and IIoT of the USA, IdF of France, MIC 2025 of China, and Africa's Agenda 2063. These initiatives can generally be described as upheavals and preparations for the imminent 4IR, and it is very important to have these forms of development, manufacturing, and industry on a global scale. However, the way in which these initiatives are executed, could take a far more innovative and disruptive form, neglecting the boundaries of countries, the dominance of the Western world, the negativity associated with the poverty of Africa and other third-world countries, neglecting race, gender, colour, and creed, and just taking hands with everybody in the global village who could contribute in however small way, to make this *world* a better place to live in. The neglecting of HE as a primary component, a stimulus, and in fact an incubator of these initiatives causes great concern for the future of HE. Will HE survive in the 4IR or will it be declared redundant? If it survives, how will it have to adapt to new circumstances and initiatives? The initiatives are there, however in which form, but at this stage, to some extent, without the collaboration of a very vibrant HE, as the latter is *lagging behind* (Atlason 2020; Jadoul 2021). This is the reason why Chamorro-Premuzic and Frankiewicz (2019b) supply six reasons why HE needs to be 'disrupted:'

29 The colonists made two decisions about the African natives: 1) They have redefined African human morality, and 2) they claimed that the 'radical otherness' of the African natives was very close to 'the perimeter of animality' (Mbembe 2001:235).

- Employees need to have skills, more than knowledge.
- The right skills, and not knowledge or titles, give a prospective employee a job.
- University fees are very high, while education levels are in fact low.
- Not knowing this, the expectations of current students are therefore too high.
- The curricula of many universities are too theoretically oriented, neglecting the practical side of students' teaching.
- Universities are thus not boosting meritocracy, but supply the workplace with ill-prepared people.

At this stage, the workplace puts more emphasis on in-service training than on degrees and diplomas. Can we really take exception that they are doing it?

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Chapter 2

Society 5.0 and Education 5.0 with Reference to Higher Education

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Introduction

Perusing the documentation of the initiatives discussed in chapter 1, it is clear that HE (higher education) does not really feature in these programmes. It seems as if HE is not fulfilling the expectations of the corporate world in relation to the 4IR (Fourth Industrial Revolution) (cf. GJ 2015:6 of 18) and therefore in-service training seems to be the alternative medium of choice for the education of employees (cf. Schroeder 2016:5). The economisation of education[1] on a global level focuses on teaching skills in the workplace. Human capital education[2] focuses on two types of education, namely the cognitive skills and knowledge that are required to work effectively, and soft skills, which are the behavioural standards required from employees. However, this is only one side of a complex picture. SDG (Sustainable Development Goal) 4, aspiration 4.7 envisages that by 2030, all learners and students should acquire the knowledge and skills needed to promote sustainable development (UNESCO 2017). Further, UNESCO (2010) states that education is expected to contribute to both national and economic development by integrating key sustainable development issues into curricula. Moscardini, Strahan, and Vlasova (2020:828) conclude that a key role of universities is to generate and transfer knowledge and skills that should lead to the positive transformation of society in a proactive, innovative way. In short, IHEs (institutions of higher education) should also be innovation incubators and the breeding ground for sustainable and positive transformation and change.

1 In general, this can be described as an economic production factor, and specifically as a tool to maximise the outcomes of the people in the workplace (cf. Spring 2014:2).

2 Education forms part of human capital, which also concerns qualities like training, intelligence, skills, and health, focusing on the value that every employer can add to the workplace (cf. Spring 2014:2).

Continuing on what was said in chapter 1, two more initiatives are discussed in this chapter, namely S5.0 (Society 5.0, developed in 2015 in Japan) and E5.0 (Education 5.0, originating in Zimbabwe), to provide a larger scope on global developments, and to zoom in on the link between societal development and HE. Japan's S5.0 refers to a collaboration between the corporate sector, government, and HE (GJ 2016). With S5.0 in mind, Fujii, Guo, and Kamoshida (2018) point out how Japanese electronics manufacturers could collaborate more with HE and consumers to create new technologies and services, whereas Shibata, Ohtsuka, Okamoto, and Takahashi (2017) make proposals about the transformation of curricula to successfully educate students who will become managers of the technologies of S5.0. Ding (2018) analyses the relationship between government, industry, and academia within the context of S5.0 and Gladden proposes a 'transdisciplinary framework' consisting of a common vocabulary allowing, for example the 'neuroscientists, computer scientists, and ergonomists,' being the developers of a 'cyber-physical human-computer interface,' to communicate, debate, and strategise seamlessly (Gladden 2019:28 of 39).

In 2019, Zimbabwe instilled E5.0, creating high expectations about the prioritising of HE, both locally and internationally, as this sounded to be a continuation and further development of E4.0 (Education 4.0). However, this programme does not directly address the improvement of HE, nor does it have a global perspective, in contrast to E4.0 (cf. Hussin 2018:92-98; James 2019). The title of this initiative is misleading. The programme is an expansion of the three basic key focus areas of universities (teaching and learning, research, and community engagement) by adding innovation and industrialisation as the fourth and fifth key focus areas (Jonathan 2019) – which was then named E5.0. This is in fact a national directive aiming at problem solving through the use of the country's natural resources to attain upper-middle income status by 2030.

Japan and Zimbabwe are more or less on the two opposite sides of the list[3] that ranks socially advanced countries. Japan was listed at number 15 in 2015. Through the S5.0 initiative, Japan moved up to ninth position in 2021. Zimbabwe ranked at number 134 in the 2021 index (Szmigiera 2022).

3 Rather than focusing on the economic growth of countries, the social progress index (Szmigiera 2022) uses 53 indicators to evaluate how countries cater for the social and environmental needs of their citizens. The indicators are categorised under three main topics: Basic human needs, foundations of wellbeing, and opportunities.

Society 5.0[4]

In anticipation of the global trends and the dawning 4IR, 5BP (the Fifth Science and Technology Basic Plan, also called the Fifth Basic Plan) presented S5.0 (Society 5.0) in 2015 as a core concept for innovation and development in Japan,[5] which the Japanese cabinet accepted in January 2016 (Fukuyama 2018:47; Önday 2019:1 of 6). The plan was to discuss whether STI (science, technology, and innovation) would be able to contribute to a viable and comprehensive global development, ensuring a better future for the economy, as well as the specific needs of society and individuals (GJ 2015:1 of 18). The challenge was to create future industries, thereby transforming their environment into a 'super smart society' called S5.0 (GJ 2015:1 of 18). Their aim was to create a human-centred society, with a lively collaboration and interaction between humans and artificial entities. These entities would be able to perform their tasks as instructed by their human operators, with the capacity to 'learn, decide, and act for themselves' in self-directed ways (Gladden 2019:1 of 39). Wang, Yuan, Wang, and Qin (2018:6) calls it 'parallel intelligence' that extends the traditional theories on AI (artificial intelligence)

4 Harayama (2017:10; cf. Fukuyama 2018:47) looks back at where S5.0 originates: It all started with S1.0 (Society 1.0) where the hunter-gatherers coexisted harmoniously with nature. During S2.0 (Society 2.0) these people started to form groups in order to organise their agricultural cultivation and for the purposes of nation-building. S3.0 (Society 3.0) started the industrial revolution era, with industrialisation that made mass production possible. S4.0 (Society 4.0) focused on an information society, connecting immaterial assets into information networks. S5.0 is also an information society, building on S4.0, but it is more human-centred (cf. Önday 2019:2 of 6). Whereas the previous 'Societies' were universal with very little hegemonic features attached to them, S5.0 is a Japan initiative, aiming at working together with 'the world,' but not on an equal basis.

5 11 systems were identified for developing the 2015 Comprehensive Strategy, namely to enhance the 'energy value chain;' to build an information platform within a global environment; to maintain and better the country's infrastructure; to develop the skills of the nation to fend themselves against natural disasters; to develop better and more intelligent transportation; to innovate the manufacturing systems of the country; to develop its own materials; to promote a care system for the community; and to enhance its hospitality systems, its food chain systems, and smart production systems, with the industry, academia, and the government as main role players (GJ 2015:14 of 18). A common platform will gradually be created to coordinate the collaboration between systems to develop new services. The core systems that will be developed, are 'intelligent transportation systems, optimizing the energy value chain, and new manufacturing systems' (GJ 2015:14-15 of 18). These will be followed by the promotion of 'community care systems, smart food chain systems, and smart production systems' (GJ 2015:15 of 18). In this way, they aim to establish a 'super smart society service platform' that will utilise IoT to establish a super smart society (GJ 2015:15 of 18).

to the emerging CPSS (cyber-physical-social systems; cf. Gladden 2019:1 of 39).[6] In this society, the numerous needs of the people are addressed, with high quality products and services, without any differentiation between or discrimination against anyone (GJ 2015:13 of 18; cf. Harayama 2017:10).

The Growth Strategy Council was formed by government ministers, academics, and company CEOs (chief executive officers). The council set up committees linked to five key themes: 1) The development of next-generation smart/mobility cities, 2) the provision of smart public services, 3) developing next-generation infrastructure, 4) creating a FinTech or financial technology driven or cashless society, and 5) providing next-generation healthcare to all (UNESCO 2022).

S5.0 has incorporated Germany's I4.0 (Industry 4.0) vision to some extent (Arsovski 2019:775; Salimova, Guskova, Krakovskaya, & Sirota 2019:2 of 7). While I4.0 focuses on production, the aim of S5.0 is to put humans at the centre of innovation (Ferreira & Serpa 2018:26, 28). Enhancing the quality of life in establishing the super smart society, is fundamentally part of this, with IoT (the internet of things) at its core (Arsovski 2019:776-778). Equal opportunities and the potential of each individual should be realised and optimised within the workplace (Bryndin 2018:12). S5.0 is established while taking note of places in the world where ICT (information and communications technology) is fully utilised, especially in the manufacturing sector. Examples are I4.0 of Germany,[7] AMP (Advanced Manufacturing Partnership) of the USA, and MIC (Made in China) 2025 by China, being discussed in the previous chapter (cf. GJ 2015:13 of 18). All these industries aim to bring about change within the 4IR and are based on partnerships between corporate markets and local governments.

S5.0 proposes to enhance the human-technology relationship in order to create a better quality of life for the people in the imminent smart society (Ferreira & Serpa 2018; cf. Serpa & Ferreira 2018). Technology should therefore be able to support the interaction between human and 'machine' (Ferreira & Serpa 2018). According to Hayashi, Sasajima, Takayanagi, and Kanamaru (2017:264), the aim of S5.0 is the creation of new values through the cooperation of a variety of systems. Japan also plans to standardise data formats, as well as data models and system architectures. This country's competitiveness in the world as a super smart society is to be enhanced with

6 More specifically, parallel intelligence is particularly effective in dealing with 'human-in-the-loop'-type issues with 'both social complexity and engineering complexity, and aims at seeking agile, focused, and convergent solutions to these uncertain, diversified, and complex issues' (Gladden 2019:1 of 39).

7 S5.0 utilises the 'rapidly evolving technologies' of I4.0 to improve the lives of its people (Gladden 2019:2 of 39).

the development of intellectual properties, 'international standardization, IoT system construction technologies, big data analysis technologies, [and] artificial intelligence technologies' (Hayashi *et al.* 2017:264).

The impetus for this plan was the 'upheaval' in which the current world finds itself (GJ 2015:1 of 18), with a new way – a 'reality' – of communication and collaboration between people, information, and organisations on a global scale, creating new businesses and markets, and influencing each other (GJ 2015:3 of 18). Japan brought teams of people together who are diversely specialised, to mutually create the desired new knowledge and values, and to create networks of specialisation, especially with regards to IoT, AI, and other relevant sciences. Four policy pillars were identified for this initiative, called the 5BP:[8] The 'fundamentals' or foundation referred to under pillar 3 specifically concerns HE with reference to researchers and their research and knowledge needed for innovation. Under pillar 4, the aim is to exchange people, knowledge, and funds by bringing companies, IHEs, and public research institutions together on a global scale (GJ 2015:9 of 18). Through this, Japan hopes to establish global research networks *under their leadership*. This concept was regarded to be an alternative solution for Japan to reach more effectiveness and mobility 'in an integrated, complex and privacy-protecting' way (Mashur, Gunawan, Fitriany, Ashoer, Hidayat, & Aditya 2019). To promote these pillars, the 5BP has in mind to create a deeper relationship with society – to win trust, understanding, and support through dialogue and collaboration (GJ 2015:9 of 18). The main proponents of society are *inter alia*, IHEs, public research institutions, and corporative institutions.

Fukuyama (2018:48) also refers to the fusion of cyberspace and physical space in order to generate quality data. This will lead to the creation of new values and solutions to settle challenges. These goals are in line with the SDGs (sustainable development goals) of the UNDP (United Nations Development Program).[9] In this way S5.0 will become a 'cyber-physical system,' connected by ICT – distinguishing itself from the four previous phases of human society (Gladden 2019:4 of 39).

8 These are: 1) The search for a new value to develop the industry and social transformation of Japan; 2) a way to address all the economic and social challenges; 3) a way to reinforce the so-called fundamentals for STI; and 4) a search for human resources and knowledge, as well as funding for the plan (GJ 2015:8-9 of 18).

9 With its objectives in line with the SDGs of the UNDP, S5.0 is, according to Önday (2019:1, 2 of 6), not just restricted to Japan, but constitutes a way to comply to some of these SDGs. According to Salimova *et al.* (2019:4 of 7), Russia made use of S5.0, creating their own 'Data Economy Russia 2024.' Mashur *et al.* (2019) refer to Indonesia, partaking in a part of S5.0, with the accent on online transportation (cf. also Suharsono & Uluwiyah 2020). Savaneviciene, Statnicke, and Vaitkevicius (2019) report about Lithuania who also utilises S5.0.

Keidanren (2016:10 of 25), the Japan Business Federation who is in collaboration with the government of Japan towards S5.0, presents the following aims: First, all people should be safe. Second, the productivity of the country must be improved through digitisation with the reformation of business models. Innovation and globalisation must take priority. Third, issues that must be addressed, are the decline in the population, the aging society, and the control over the impact of natural disasters. Lastly, businesses and services must expand to solve worldwide issues.

The people who are expected to take the lead in this initiative are the researchers at IHEs together with the developers and innovators in the private sector (GJ 2015:1 of 18). IHEs are therefore paramount in this process but need to be 'reformed' to form a viable partnership between academia, industry, government, and the broad public (GJ 2015:1 of 18). The aim is the growth of the national economy, job creation, better internet security, to make people more prosperous, and to take care of and contribute to global development (GJ 2015:2 of 18). However, the 5BP also notes the 'gap between company needs and the knowledge and technology produced by universities' (GJ 2015:6 of 18) – the IHEs, which are one of the main proponents in the STI activity, are not up to standard, with respect to their management, their human resource systems, as well as their organisational reform.

The Centre for Research and Development Strategy: Japan Science and Technology Agency cautions that, although the progression of IT (information technology) will afford everybody with prospects of innovation and prosperity because of the collaboration between humans and technology, there is also a possibility of 'unprecedented ethical, legal, social, security, privacy and safety challenges' that should be taken care of (CRDS 2017:1).

Despite the challenges faced by S5.0, this initiative could indeed be an example for other countries to up their programmes for production and innovation.

Education 5.0

The main aim of this programme is to make Zimbabwe a 'competitive, industrialised and modernised nation by 2030' (MHTESTD 2019:ii; cf. GZ 2018; Scherer 2019). The knowledge that this country wants to produce through E5.0 (Education 5.0) should result in the rendering of goods and services to its people by using the country's own resources and promoting heritage-based education. The programme anchored itself in THE (tertiary and higher education) and heritage-based STD (science and technology development), while ESTD (education, science, and technology development) should create and develop industry, and not *vice versa*. To reach this aim, the Ministry of Higher Tertiary Education, Science and Technology Development presented a

'doctrine' to provide a philosophy for E5.0 and its concomitant industrialisation (MHTESTD 2019:1), also supplying the principles that would guide the HTESTS (higher and tertiary education, science and technology system) in Zimbabwe. The science initiative to produce innovation and industrialisation will be driven by the NSTI (National Science Technology Innovation System). E5.0, which is the umbrella for all of these, should therefore be all about teaching, research, community service, innovation, and industrialisation.

According to MHTESTD (2019:2.1), the heritage-based education of Zimbabwe will be delivered with a consciousness of the environment, focusing on fauna and flora, as well as water and minerals. The process of teaching and learning will therefore focus on the local environment and locally available materials. The government has added innovation and industrialisation (MHTESTD 2019:3.1) to the three core activities of universities:

- *Teaching* (*and learning*): Technology should be presented in familiar, understandable terms to the students.
- *Research* (*and development*): This will act as the impetus for innovation and other new ideas (MHTESTD 2019:3.1.2).
- *Community service*: The educational community should be developed to become globally competitive.
- *Innovation*: This acts as the bridge between the knowledge obtained in the classroom, and laboratories and industrial production (MHTESTD 2019:3.1.4).
- *Industrialisation*: The so-called 'industrial park' will act as the final stage for producing goods and services (MHTESTD 2019:3.1.5).

To achieve the set outcomes, the process will use the following infrastructures:

- *Programme infrastructure*: Specific training programmes will be implemented, prioritising education and training, so that the government can achieve its industrialisation and modernisation agenda (MHTESTD 2019:3.2.1).
- *Promotion infrastructure*: Promotion will take place at the IHEs, as well as on tertiary education level.
- *Physical infrastructure*: With the focus on the erection of structures for education, investors will be engaged with PPS (public private partnerships), BOT (build, operate, and transfer), and BOOT (build, own, operate, and transfer) arrangements. The following will be erected: University towns and cities, colleges, modern accommodation, shopping malls inside the universities, wi-fi, and more innovation hubs (MHTESTD 2019:3.2.3).
- *Financing infrastructure*: This facility will act to assist students who cannot pay their education loans.

The focus of strategic science and technology developments will be on the following:

- *Geospatial, aeronautical, and space science*: ZINGSA (Zimbabwe national geospatial and space agency) will establish and streamline the use of aerospace and outer space, in collaboration with other nations (MHTESTD 2019:4.1). The following initiatives are planned: Geospatial science and Earth observation, aeronautical and astronautical engineering, satellite communication systems, global navigation satellite systems, land positioning systems, unmanned aerial vehicles, and satellites (MHTESTD 2019:4.1).
- *Information communication and technology*: By means of an HPC (high performance computing) programme for research and development, problems will be solved in, and benefits derived from, *inter alia*, agriculture, weather and climate research, engineering, life sciences, space sciences, and mining (MHTESTD 2019:4.2). The development of a virtual and augmented reality centre is also planned.
- *Energy and minerals research*: This programme consists of three sub-programmes, namely petrochemical, fertiliser, and steel products. With this, the government wants to provide the nation with 'alternative forms of sustainable energy [by doing more research on] alternative sources of liquid fuels, [with their available] abundant local coal and coal bed methane gas resources' in mind (MHTESTD 2019:4.3). At least two plants are planned: A coal-to-liquid fuel plant and a coal-to-fertiliser plant (MHTESTD 2019:4.3). The initial target is the production of eight million litres of liquid fuel and other petroleum products per day, while the local iron ore resources will be used to produce steel.

In the biotechnology sector, the genomic technologies programme will address human challenges (treatment of HIV; screening of new-borns for inherited diseases; 'forensic DNA for crime investigation'), flora challenges, and cattle reproductive technologies for beef production (MHTESTD 2019:4.4).

Zimbabwe's government wants to create an economy driven by science and technology. The economy will be industrialised to create jobs and provide solutions for industry problems (Jonathan 2019). Innovation hubs and industrial parks will be erected where the consumers can become active contributors to the chain of production (MHTESTD 2019:5.1). This will contribute to the creation of jobs and will uplift the standard of life of the people in Zimbabwe. In the innovation hubs, an active knowledge transfer will take place between 'researchers and business experts' (MHTESTD 2019:5.1.1), creating fertile ground for the development of technology. This knowledge will then be used by industrial parks which will act as production centres, where business will be transformed into commercial goods and services (MHTESTD 2019:5.1.2).

This will ease the rise of both SMEs (small and medium enterprises) and large enterprises, facilitating cross-learning between the participants. In 2021, the first fruits of the innovation hubs were displayed (Bope 2021): The policy that focuses on the needs of people and assuring that no-one will be left behind, was made practical by the demonstration of mobile phone applications for the blind and visually impaired individuals.

The NSTI is the implementation strategy for STD, outlining the channel of knowledge on the management of the production of goods and services to industrialise and modernise Zimbabwe (MHTESTD 2019:6). The strategy is focused on products, ensuring that all the initiatives are aimed at a specific goal and clear outcomes (programmatic approach).

The Initiatives Revisited

Although E5.0 gives the impression that it is an improvement of E4.0 and therefore highly advanced, this is not the case. According to Hussin (2018:92-93), E4.0 consists of nine tendencies or trends, referring to the way in which learning takes place (anytime and anywhere; personalised; where students decide in which way they want to learn and do field work), the characteristics of learning (project-based; hands-on; and diverse assessment methods), and the role of the educator (being only a mentor, guide, or facilitator, with the students as partners – cf. also Doucet 2018:58). It would be expected that E5.0 would progressively innovate and elaborate on these trends, showing the world a better, more innovative, and more viable way to do education, even on a global scale. However, E5.0 is in a way an expansion of the Western colonial-based E3.0 (Education 3.0) with the intention to break away from it (Bope 2021).

Zimbabwe's E5.0 has little global vision. References to 'global' are made in collaboration programmes, like ZINGSA, where Zimbabwe has in mind to work hand-in-hand with other countries to enter space. To incorporate both the educational revamp and the global initiatives, this programme should rather be called 'Made in Zimbabwe 2030.'

Unfortunately, other similar educational reform policies implemented in Zimbabwe in recent years (such as STEM [science, technology, engineering, and mathematics] and the review for primary and secondary education) dismally failed (Keche 2021). Issues like the Covid-19 pandemic, a lack of funding, the high cost of technology-enabled devices, network and electricity outages, political and economic instability, and the lack of ownership by HE educators who feel that these additional focus areas and the implementation of technology intensify their administrative workload, already indicate that E5.0 will probably also fail. Educators in IHEs claim that the 'new' focus areas of innovation and industrialisation already formed part of their work in a top-

down approach by government, before this was implemented and therefore this exposed the lack of cooperation between HE and the governing bodies (Keche 2021).

On the positive side, the innovation hubs already produced workable products that are driving positive social change as indicated above. Within HE itself, the MBKS (Minimum Bodies of Knowledge and Skills) programme is managed to harmonise the core content of similar degrees across universities into an agreed course synopsis of 80% (Mpofu-Hamadziripi, Rauch, & Dulle 2022:3 of 7). This confirms that Zimbabwe does already show evidence that the transformation trajectory is showing positive results. Zimbabwe succeeded to infuse the local African heritage-based philosophy (which is based on people's resources, history, traditions, religion, language, and the physical and metaphysical environment) into their curricula to industrialise the economy through using the country's natural resources, knowledge, and culture. This is in line with the Africa Agenda 2030 (Mpofu-Hamadziripi *et al.* 2022:3 of 7).

In Japan, education is referred to as one of the collaborators or partners of the initiative that aims to solve the current problems of the country as well as working towards inclusiveness and sustainability, based on a cyber-physical system. Education (IHEs) also acts as one of the main proponents of society, together with public research institutions and corporative institutions. HE must recognise its social responsibility and ensure that the development of competencies for work, 'the consumption of culture, adaptation to continuously changing environments, ownership of basic concepts,' and interaction with the environment and others, along with social and personal development are incorporated in all programmes and modules at IHEs (Narvaes Rojas, Alomia Peñafiel, & Loaiza Buitrago 2021:11 of 16). This will ensure that partnerships and collaboration between academia, government, and industry increases while promoting the mobility of researchers between them (Narvaes Rojas *et al.* 2021:11 of 16).

In comparison to I4.0 which is focused on creating a 'smart factory,' S5.0 is focused on supporting a 'super smart society' (cf. Gladden 2019:2 of 39), with the aim to produce and fashion a 'sustainable, vibrant, liveable people-centric world' (Medina-Borja 2017:235). Both I4.0 and S5.0 are aiming to create more sophisticated 'cyber-physical systems,' relying on 'embedded, decentralized, real-time computation' that forms part of an overarching network of 'heterogeneous physical objects' (Gladden 2019:3 of 39). However, Japan with a more human-centred focus, has come up with a better consumer experience than, for example Germany, as well as products that are more 'feature-oriented' (Schneider 2018).

S5.0 has the potential to connect all people and their needs – without discrimination – that will overcome social disparities. Information overload can be regulated by technology, while education will be affordable and freely available to all (Van der Merwe 2021). Grade progression will be made flexible and the barriers between disciplines and subjects will be removed. The division between STEM and Humanities, and social sciences students will be dissolved to develop a HE system where subjects like mathematic, data science and programming, as well as languages, philosophy, and ethics will be basic requirements for every student (FP 2022). The overall focus is on enhancing human strengths through the development of skills like communication, leadership, endurance, as well as the promotion of curiosity, reading skills, and comprehension (FP 2022).

On the negative side, care must be taken to ensure that these developments do not create new or larger problems and issues (Van der Merwe 2021).

Lastly, the question that should be posed to both these 'fives,' concerns the globality or global availability of these initiatives. The previous 'Societies' and 'Educations' were global initiatives that influenced 'everybody' and were utilised by 'everyone.' In Japan, the fourth pillar of the 5BP (Fifth Basic Plan) states that S5.0 wants to collaborate with other countries by exchanging people and knowledge, and by bringing IHEs and public research institutions together on a global scale (GJ 2015:9 of 18). However, the impression is clear that Japan will be the leader and the global village will have to follow and collaborate. There is therefore a personal hegemony encrypted into this initiative, something like copyright – one may use it, but it will stay Japan's property. Contrasted to S4.0, which was a global initiative, S5.0 is a local initiative available for the world to use under the 'auspices' and control of Japan.

It seems as if most countries (as discussed in chapters 1 and 2) are not prepared to collaborate on an equal basis with each other. Therefore there should be more pressure and maybe also incentives from global bodies to promote collaboration on a more global and broader scale. One way of achieving this is through the internationalisation of HE. Here, the French-German Institute for 'Industry of the future,' Erasmus+, and ASEAN (see the introduction chapter) are good examples of what could be done. Internationalisation and globalisation should become the two legs on which global education functions. However, globalisation should not allow for the hegemony or dominance of one country over the other, but should aim for heterogenisation, creating a multicultural society where cultures and traditions are accepted and respected. It is on this point that S5.0 has other priorities. Although Japan has collaboration as a top priority, the equal basis of participation is missing, as Japan aims to become one of the top countries in

the world. However, it is true that Japan is facing some serious problems such as an ageing population and slow demographic growth which the country will first have to successfully address for its own people before it can share its experience and recommendations with the world (UNESCO 2022).

The other side of the coin is equally true. Internationalisation, together with globalisation and heterogenisation, is already a given and needs to be implemented by governments and IHEs on a global basis. Isolation and national(ist) perspectives cannot effectively be linked to the 4IR. In this respect, E5.0 will stay a national venture.

Conclusion

Already in 2015, the UN (United Nations; UN 2015) challenge *all nations to work together* to create a sustainable world on both economic and societal levels (Fukuyama 2018:47). Japan understood this as a call to become a leader that collaborate with other countries. Zimbabwe responded to the challenge by creating E5.0. However, both these initiatives centre around the interests of the two respective countries, in contrast to the 'Societies' and 'Educations' as mentioned above. On the positive side, both initiatives discussed in this chapter do acknowledge (to some extent) the importance of HE to succeed.

Nobody can foretell the future. Nobody can therefore predict what the 4IR will look like in a decade's time. We are also unable to predict how far the other revolutions, like the communication revolution, the education revolution, and the human self-understanding revolution (referred to in the introduction chapter), as well as societal developments will advance. We are likewise unable to prevent global disasters or pandemics such as Covid-19. We can only constructively and 'disruptively' take on the road to the future, step by step, with all its complexities and transformations. We can read the signs of the times, such as acknowledging that the 4IR is blurring lines and borders to such an extent that we cannot ignore the consequences thereof, also in other spheres of life such as education, social interaction, and even religion. The prerequisite is that we must stay on par or attempt to leap to the front, all within the international rules and guidelines such as those provided by UNESCO and the SDGs. It is imperative that all countries of the world should work in harmony and support of each other to create a sustainable society that ensures safety and comfort for each individual while also ensuring that all possible opportunities and needs are catered for in the best possible way. This will only be possible when society, industry, education, and governments (globally) collaborate without exclusion or discrimination.

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Chapter 3

The Role of American Universities in Advanced Manufacturing

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Introduction

American HE (higher education) has long been involved in research about the technologies behind what is known as the 4IR (Fourth Industrial Revolution), but has also been divorced from the 'industrial' part of that revolution. Thus, while American HE has supported extensive technology research in such areas as IT (information technology), advanced materials, and AI (artificial intelligence), it has not been nearly as involved in research on the related manufacturing technologies and processes. However, stagnating industrial productivity rates and a sharp decline in manufacturing employment forced the US, starting in 2012 to consider what has been termed 'advanced manufacturing.' The solutions considered were oriented towards applying the nation's capabilities in technology innovation to its manufacturing sector. Since research universities in the American innovation system play an important role in technology research, these schools are now starting to be brought into this effort to upgrade manufacturing. How did this disconnect between university research and manufacturing technologies and processes come about?

The advent of large-scale, federally funded research during World War II, which continued in the post-war period, enabled the US to build a network of strong, research-based universities. Much of this research enabled follow-on technology development, as the US was able to orient its economy around an innovation-based growth model. However, because the US was the unchallenged leader of mass production coming out of World War II, it simply assumed that this production leadership would continue while it was creating its research and development support mechanisms (Bonvillian & Singer 2018:34-35). This federally funded R&D (research and development) was directed towards research and focused technology development, but not towards manufacturing innovation. R&D is a preliminary stage on the path to

innovation, which embodies not only the R&D but the full implementation of technology into societal use. Manufacturing largely was left out of both federally-funded R&D as well as follow-on innovation efforts.

Although a succession of global manufacturing challengers arose in recent decades, including Japan, Germany, Korea, Taiwan, and now China, the US innovation system never took up the challenge, causing those nations to make significant inroads on the US share of global production. The strong university research system was simply not applied to manufacturing technologies – university research and manufacturing technologies were disconnected. Many quality manufacturing jobs began to disappear as global competition rose and US multinationals used a distributed production approach to shift production abroad. However, when China passed the US in manufacturing output in 2011, and a major social disruption developed for the American working class, the realisation began dawning among policymakers about the consequences of ignoring production. The Obama administration initiated an innovation-oriented policy approach to manufacturing and began enlisting American research universities in the cause. This started a process to better connect production and the still strong US innovation system with universities playing a major role.

This chapter reviews the nature of the production challenges facing the US, including the widespread social disruption that came from the decline of its manufacturing sector and the important role of production in innovation capability. It then turns to the new innovation policy approaches that the US adopted for manufacturing in response to the challenges starting in 2012. At the forefront of that response is a new role for US universities in production innovation. The US university role since the post-war has been in basic research and education for the liberal arts, but universities are now helping to lead the new AMIs (Advanced Manufacturing Institutes) and gradually expanding their work on manufacturing-related R&D. However, there is a parallel issue that they must also address: The talent base for innovative manufacturing universities is not only for research, as education remains a primary function. In addition to research, they are starting to work on the related challenge of new manufacturing workforce education. The manufacturing challenge is requiring universities, therefore, to undertake more applied work in manufacturing technologies, as well as more workforce education for those new technologies. Pending manufacturing initiatives are now pushing universities in those directions.

The American Manufacturing Challenge

Manufacturing decline has been linked to extensive social disruption in the US during the first two decades of the 21st century. The decade between

2000 and 2010 was a painful one for US production: Manufacturing employment decreased by 5.8 million jobs – by almost a third – from 17.3 million to 11.5 million. By 2015, it had only recovered to the 12 million job level (Manufacturers Alliance 2018). Manufacturing, historically, was a very important middle-class pathway for high school educated males, but that group has been experiencing a very significant labour non-participation rate in the US – the share of these men of prime working age not working at all, reached 18% in 2013 (Pew Research Center 2014). Importantly, the median income for men with less than high school educations decreased by 20% between 1990 and 2013 (Kearney, Hershbein, & Jacome 2015). There is also a growing income split between college and non-college educated, leading to a major rise in US income inequality. Therefore, restoring manufacturing was a frequently cited subject in the divisive 2016 presidential election and thereafter. In a country that prided itself on its social mobility, this was a clear signal of a loss to middle-income ranks, of growing social inequality, and a post-industrial backlash. Below, we will review key problems in the US manufacturing system that helped create these issues.[1] Then we will turn to the questions of whether advanced manufacturing can speak to it and what the university role could be.

Problem #1: Low Productivity

Although the US lost nearly one-third of its manufacturing jobs in the 2000s, economists thought its manufacturing output was holding firm. However, on re-examination, experts found that it was in decline in some 16 of the 19 manufacturing sectors measured. Because output is a component of productivity, it meant limited productivity gains. Therefore, the US' overall productivity from 1995 to 2005 was 2.5%, yet from 2005 to 2015 it was in the 1% range (BLS 2018, 2019; cf. also Houseman 2018). Since investment in capital and plant can help to drive productivity, this meant that these numbers were down as well. The US has also been running a staggering trade deficit in manufactured goods of some $900 billion a year – an unprecedented level (Statista n.d.). This includes a $190 billion deficit in advanced technology goods (BEA 2021). The job loss data cited above were not due to productivity advances, it was due to a hollowing out of US manufacturing, largely due to international competition, particularly from China. The low productivity numbers are a signal of the limited entry of innovation into the production. Since one key arm of the US innovation ecosystem is university R&D, it is also a signal of the manufacturing-university disconnect.

1 These problems are discussed in more detail in Bonvillian and Singer (2018:1-100).

Problem #2: A Thinned-Out Manufacturing Ecosystem

The US used to have firms and supply chains in manufacturing that were very vertically integrated, but the prevailing financial model emphasised short-term, quarterly returns. This led manufacturing firms to reduce risk through a focus on their core competency which, in turn, led them to go what was called 'asset light.' The IT revolution, with programmed specifications tied to programmed machines, enabled these firms to delink production from design. The financial pressure and the IT capability led to massive outsourcing and offshoring of production. Additionally, the US closed over 60,000 factories in the 2000 to 2010 period (BLS n.d.). The US has therefore been thinning out its manufacturing ecosystem. The shared assets in the manufacturing system and training, bringing best practices to suppliers, declined. It is therefore thinner out there – there is less in the ecosystem. The small and mid-sized companies in the US system, in Suzanne Berger's terms, are now more 'home alone' (Berger 2013). This 'home alone' problem has many elements, but it is also a signal of the disconnection between university research and manufacturing.

Problem #3: Manufacturing Scale-Up

While the US has many industrial sectors, there are essentially three kinds of manufacturing firms. The first category is large multinationals. They are global and can get production efficiencies by producing in lower-cost countries, where they need to be anyway to participate in global markets. These firms are generally doing well, although the firms have been increasingly producing abroad with consequences for US employment and production capability. However, there are two more vulnerable sectors. The second category is 'main street' firms – the SMMs (small and mid-sized manufacturers) that produce slightly less than half of the US manufacturing output. There are about 250,000 of these SMMs with under 500 employees. They tend, by nature, to be thinly capitalised, and are risk averse to survive. They do not perform science and engineering-based R&D, so they have limited access to innovation, although they can be innovative about adapting their products. Starting in the 1980s, they fell well behind larger US manufacturers in productivity advances (Helper & Mahoney 2017). While there are innovative firms in the mix, as a group they are falling behind in manufacturing advances. Yet, because they account for so much output, too often they are a drag on the overall system. The third category is entrepreneurial start-up firms that make something. The US has had a strong emphasis on such start-ups as a way to bring innovation into its economy and developed a strong system of venture capital to back them. These firms do well until they need to scale up for production. Because the venture capital system in the US is now overwhelmingly focused on software, biotech, and service firms for their short term return window,

financing for start-up scale-up is largely unavailable for new manufacturing firms (Bonvillian & Singer 2018:194, 185-215). They are too risky and cannot get to significant production within the necessary five to seven year window. These firms are therefore not scaling up, limiting the innovative firms coming into American manufacturing. If they do scale-up, they must turn to contract manufacturers and prototypers abroad, particularly in China. Since many US start-ups emerge from university research, this is another signal, too, of the university-manufacturing disconnect.

Problem #4: Seeing Manufacturing as Part of Innovation

The US has not pictured manufacturing as part of innovation. It thinks of R&D as innovation, but this is a fragmented perspective. In fact, innovation really is a system from early-stage research through the production function. Production is the enabler of what economists call 'increasing returns in an economy.' While services scale slowly because they tend to be more face-to-face, manufacturing is the scalable factor, which can scale quickly through mass production technologies. It is a foundational societal wealth creator. Treating production as a critical element that has to be connected to our innovation system is therefore critical, otherwise there is a risk of innovation erosion.

Back in the post-war period, when it was building much of its innovation system, the US would both *innovate here and produce here*. As a result, it got the full spectrum of gains from both sides in our economy. Then, largely through digital technologies, it figured out how to *innovate here and produce there*, achieving distributed production (Bonvillian & Singer 2018:57-58). However, for many products, the tie between innovation and initial production is very tight. Dense feedback loops are needed for product design. This initial production requires very creative engineering and design which is very much part of innovation, particularly if one is focusing on bringing out a new technology advance. However, if one shifts production, in many cases the innovation capability has to go with it. For example, a small firm may attempt to shift its production to a contract manufacturer in Asia to reduce its cost and risk. It does the initial design in the US, then sends that design to Asia where it is produced. However, then comes the time to do the incremental improvements. The design team has to go live with the Asian producer because it needs to be close to the actual production process.

The risk here for the US manufacturers that shifted their production capability, is that the innovation capability may have to follow production. The result is a growing problem for the US: *Produce there, innovate there*. If innovation is the US' strong suit, then this is a genuine issue for the future of its innovation capability: If important innovations have to follow production, this endangers the core innovation strength. Since universities are a core

element in the US innovation system, this has important implications for the future of university R&D as well, and speaks to the need to integrate them better into the production system.

Problem #5: Lessons from Germany

Most people in the US thought it had to lose manufacturing jobs to low-cost producers in Asia because it was high wage. Germany stands as alternative model because it has a much higher manufacturing wage than even the US. Yet, Germany is running a massive manufacturing surplus, including a manufacturing surplus with Asian nations. What is Germany doing right – are there some lessons for the US to learn?

Just because the US is facing low-wage competitors, does not mean that it has to give up on manufacturing. While 8% of the US workforce is in manufacturing, 20% of the German workforce is. Germany created and retained a deep ecosystem for its manufacturers, small and large – they are not home alone. There is an extensive collaborative R&D shared by industry, government, and engineering universities around new manufacturing technologies and processes through a network of over 60 Fraunhofer Institutes throughout the nation (Bonvillian & Singer 2018:178-183; Fraunhofer-Gesellschaft. n.d.). There is also a famous shared training system, for its workforce through apprenticeships. Its manufacturers also have ways to link their supply chains together in a collaborative way for rapid scale-up.

Germany is a very different country than the US and only some of its approaches are suited to replication. Their workforce training system is difficult to adopt, although modified apprenticeships work, and the Fraunhofer Institutes could be adapted, as will be discussed below. These would work to integrate university engineering research into their production system.

Problem #6: The Hourglass

Envision an hourglass which we will use to describe the manufacturing system (Bonvillian & Singer 2018:59-63). On the top globe of the hourglass where the sand flows down towards the narrow neck, are resources, suppliers, components, and R&D. The narrow neck of the hourglass is the production moment. In the neck are 12 million manufacturing jobs and over 250,000 firms. Then, flowing out of that production moment is the bottom globe of the hourglass which contains all the distributions, sales, repairs, and lifecycle industries that support the product. The production moment is the smallest part of the hourglass. The firms in the upper globe that provide resources, supplies, components, and R&D are a much larger part of the economy, as are the firms and jobs in the bottom globe with distribution, sales, and repairs. All of these elements and firms make up a manufacturing system. Then,

throughout the hourglass are value chains of firms – the links between the firms in all parts of the hourglass. If we snap the narrow hourglass neck at the production moment, we disrupt the manufacturing system. Snapping our production capability, snaps the value chains of firms. Although individual firms are disrupted, the bottom globe of the manufacturing hourglass can be restored when outsourced goods are imported. However, the linked firms in the production neck and the top globe of suppliers and the scientists and engineers in the R&D system are not. When the production firms end, their work ends. The R&D part is particularly problematic, since the manufacturing industry supports 60% of the US' R&D. Therefore, when you buy the Hyundai, not the Chevy, it is impactful, and the Hyundai displaces the Chevy and its the network. The decline of US manufacturing has meant snapping very significant parts of these manufacturing value chains, affecting not simply the production firms themselves, but the networks of firms they are connected with. The impact of manufacturing decline has been widespread. Universities, as part of the innovation system, are starting to feel these effects as well.

Is there a way out of these challenges? Could the US relink production and innovation? Would advanced manufacturing be a way of rebuilding these value chains? Is better integration of university research into the production system part of the answer?

Manufacturing Innovation Policies

While the US led in the creation of interchangeable machine-made parts in the 19th century and applied those technologies to enable mass production, which this country has dominated in the 20th century, it has not focused its innovation system on manufacturing processes and technologies. While this system has emphasised development of areas such as aerospace, computing, the internet, and software, there has not been comparable R&D support for manufacturing. As noted at the outset, the US has set up much of its innovation system in the period following World War II. At that time, it dominated the world manufacturing capacity and output. It therefore focused its R&D system on areas that needed more attention, basic research, and new technology development. In contrast, Germany and Japan, rebuilding their economies after the war, focused on what can be called 'Manufacturing-Led' innovation (Bonvillian & Weiss 2015:184-185). Subsequently, Korea, Taiwan, and now also China adopted a similar manufacturing focus. China has already passed the US in manufacturing output in 2011. This prompted the US in recent years to consider a new effort on technology and process development in production. Facing competition from lower-wage and lower-cost competitors, improved manufacturing productivity, while efficiency appeared to be an answer.

There appears to be new manufacturing 'paradigms' potentially at hand that could play this role. Scientists and engineers advise that advances in fields like the following could be achievable:

- *Digital production* – the acceleration of IT intensity in manufacturing, including a mix of advanced IT, radio frequency identification, and sensors for each element in the production process to become 'smart,' from resource through production through product life cycle, with new decision making tools from BDA (big data analytics), and with advanced robotics, supercomputing, and advanced simulation and modelling.
- *Advanced materials* – the ability to design all possible materials with designer features, then fitting new materials precisely to product needs for strength, flexibility, weight, and production cost. In addition, evolve new biomaterials from synthetic biology and explore biofabrication.
- *Nanomanufacturing* – fabrication at the nano-scale and the ability to imbed nano-features into products to raise the efficiency and performance thereof.
- *Mass customisation* – production of small lots at the cost of mass production, for example through 3D-printing/additive manufacturing, where products can be fabricated in highly complex forms and tied to computerised production equipment (Bonvillian & Sarma 2021:80-81).

This is only a partial list. Advances in photonics, composites, new chemical processing, flexible electronics, advanced fibres and fabrics, cyber security, power electronics, and other areas should also be considered.

If the US needs new production paradigms, there are gaps that must be filled in the innovation system to realise them. As noted, the US' R&D remains strong but one gap is that it lacks an R&D effort organised around the advanced manufacturing challenges (Bonvillian & Singer 2018:34-35). University R&D, in particular, is disconnected from production. Most of the potential paradigms need R&D input, but both R&D and implementation also require corresponding technology strategies, a second gap, developed jointly by industry, government, and university experts.

In addition to manufacturing R&D, tied to collaborative technology strategies that include applied work at universities, a third gap concerns workforce education. The advanced manufacturing technologies will not be adopted unless the workforce is ready to do so. A new training effort for advanced manufacturing is therefore required. Reports in 2012 and 2014 (PCAST 1972, 2014) by a task force of leading companies and technical universities named by the President – the AMP (Advanced Manufacturing Partnership) – led to the formation of 16 AMIs, to fill a fourth gap to help implement technology development and to support workforce education. These have been formed around technology fields as listed above. This overall

effort to develop advanced manufacturing tried to speak to the six problem areas identified above.

While US universities have historically not been significantly engaged in manufacturing technology and process development, they have performed a diagnostic role in identifying these problems in recent years, helping to foster a series of reports and studies. These reports include Berger (2013) and the National Academy of Engineering (NAE 2016; cf. also reports noted in Bonvillian & Singer 2018:303). The President's AMP, which advocated advanced manufacturing policies in its 2012 and 2014 reports, included six presidents from leading US universities.

The US borrowed its institutes from the German Fraunhofer Institute model, modifying it to fit different US circumstances and needs. The institutes are reaching nearly every state in nearly all of the new technology areas listed above (Manufacturing USA 2020). They are supported by the federal defence, energy, and commerce departments and are cost-shared by industry, state, and federal governments. Each institute is formed to pursue advances in a particular advanced technology area that could be transformative of manufacturing technologies and processes, such as robotics, additive manufacturing or digital production. Institutes attempt to deal with the gaps in the innovation system by

- connecting small and large firms to restore the thinned-out ecosystem;
- relinking innovation and production in collaborations between firms, universities, and government;
- pursuing production innovations to grow efficiencies and productivity;
- providing shared facilities for scale-up; and
- collaborating with firms and education institutions to build a skilled workforce to implement and disseminate advanced production technologies into companies.

The federal government agencies funded each institute at between $50 and $100 million for five years. Each is a non-profit consortium, typically with over 100 participating firms, universities, community colleges, and state and local government agencies. The institutes were formed, starting in 2013 and are making progress deploying these features, which address key structural issues in American manufacturing. The institutes have two underlying missions behind these points: Support applied research advanced manufacturing technologies in the technology area each institute focuses on, and support workforce education – both new content and delivery systems – in their technology field. However, the institutes have faced a limited timetable of federal government support because they initially had five-year terms. Yet, the structural problems are longer term and require longer term leveraging from federal investments, so the agencies are gradually

responding by extending support by various means. Despite this longer term funding problem, institutes have been overall quite productive in advancing new technologies and workforce programmes. At stake is the industrial base needed if the US is to have sustained technology leadership.

The University Role in Advanced Manufacturing Technology Development

Industry is only one actor. Locked in worldwide competition, it cannot undertake the risk or long-term investment to generate all of the new technologies and skilled workers required. Instead, a system was found to be needed where a connected network of firms, universities, labour, governments, as well as national and corporate labs together could nurture the next generation of production technologies, processes, and education infrastructure. Again, the market alone will not support efficient levels of investment in these networks, often called a 'manufacturing ecosystem' or 'the industrial commons.' The institute model is designed for the problem of getting to advanced manufacturing, with each institute organised to advance a specific new manufacturing technology, although the size of the overall effort requires scaling them up with additional funding. What will the university role be in this effort?

Since World War II, when the federally-funded research university approach was first adopted, these schools have supported federal agency-sponsored R&D. The federal government has obtained an enormous amount from this approach, with university research often providing the foundational breakthroughs that applied research built on for subsequent technology advance.

However, as noted above, agency support for manufacturing R&D has been a missing piece in the puzzle of the American innovation. This gap underscores a need to open up R&D funding to manufacturing. The new AMIs are an initial step towards meeting that need. They work not at basic research but at what is known in the US as Technology Readiness Levels four to seven of applied research through technology development stages. As part of this approach, 'hybrid' models are needed, where both university research teams and industry, particularly smaller, entrepreneurial firms, are engaged in R&D projects. This hybrid approach has been a hallmark of the DARPA (Defense Applied Research Projects Agency) (Bonvillian, VanAtta, & Windham 2020:101). The approach accesses the out of the box ideas that can emerge from university research, and ties them to companies' expertise in shaping technology development to bring it to market.

Institutes are a start towards the technology development that will be needed for advanced manufacturing, although a larger scale of R&D will

be required. Manufacturing is a $1.2 trillion dollar sector in the US, while the total federal cost share of the 16 manufacturing institutes is around $300 million a year. It is hard to achieve a tech revolution on the cheap, therefore other federal R&D programmes will be needed to support these efforts.

Meanwhile, universities have begun to work on manufacturing institute-funded R&D, working with companies. Because only quite limited federal R&D has been available for manufacturing in the past, this is a new research opportunity for a number of schools. However, universities have been working on the earlier research stages of areas relevant to manufacturing such as robotics, AI, and advanced materials, whereas this foundational work can translate into more direct work on manufacturing and engagement with the institutes. Thus, engagement with institutes can open up new more applied research opportunities for universities with funding through the institutes. The institutes have a deep industry involvement and leadership but are required to be led by non-profit entities. Often universities are playing that convening role and every institute has a strong involvement from regional universities, where they are undertaking not only research but helping to organise the technology agendas of the institutes.

For example, Carnegie Mellon University, which has been a leader in robotics research, led a consortium of companies and universities to compete for and form the ARM (Advanced Robotics for Manufacturing) institute which includes 270 robotics companies, other universities, state economic development agencies, and community colleges (ARM n.d.). Carnegie Mellon contributed $50 million in cost share towards the institute and is now a participant in ARM's research and workforce education projects as well as supporting the administration of the institute. Another example is MIT (Massachusetts Institute of Technology), which led the consortium in creating one manufacturing institute in advanced fibres (AFFOA n.d.; Bonvillian & Singer 2018:158-163), has been leading the workforce education part of the institute in photonics (AIM Photonics Academy n.d.), and participating in three other institutes. A third example is the University of Tennessee and the federal energy laboratory it oversees, Oak Ridge National Lab, being a leader in the IACMI (Institute for advanced composites manufacturing innovation) (IACMI n.d.; Bonvillian & Singer 2018:153-158). Many other universities are now similarly engaged.

Manufacturing, however, is not yet a significant research niche in university research. Two universities, the Georgia Institute of Technology (Georgia Tech n.d.) in Georgia, and Clemson in South Carolina (CUCAM n.d.), are exceptions. They have significant advanced manufacturing research technology centres, with manufacturing research in advanced production technologies, as well as growing education programmes in manufacturing. Both these universities are in states with expanding manufacturing sectors,

and the university centres collaborate on R&D with area manufacturers. Both universities also participate in various manufacturing institutes. If federal research in manufacturing grows, more university manufacturing technology centres could evolve similar to the programmes that the Georgia Institute of Technology and Clemson have built.

The University Role in Manufacturing Workforce Education Programmes

The US was the first nation to develop mass HE programmes and used these as an engine for economic and social mobility. A college degree is now the key differentiator for economic wellbeing (Golden & Katz 2008). However, HE is also a complex, established 'legacy' sector, reluctant to change and adopt its existing operating modes to fit new needs (Bonvillian & Weiss 2015:96-112). Although its existing degree credentials are largely disconnected from actual job skills, it has become a default credential for employers because there are no others that are as widely accepted and used. But although the degree is the crucial credential for employment, the content of what is being taught largely does not reflect what the employers are now seeking.

Colleges and universities are now finding themselves in a box (Bonvillian & Sarma 2021:118). Clear trends in the workforce show that ever-higher skills – called upskilling – particularly with the entry of ITs, are being required for success in the workforce. The achievement of HE is now critical to finding quality jobs, and the jobs for those with lesser skills are in decline. Within HE, the four-year college degree is increasingly the critical achievement; the two-year associate degree is now required, while the pressure, as the employment data show, is increasingly towards the four-year degree. While the high (secondary) school degree was long the acceptable basic credential, that has now been displaced.

Yet, universities as legacy institutions have been ignoring these workforce developments, maintaining their own separate traditions of what they have taught, largely avoiding more workplace-related content. However, now pressure for workforce credentialing is starting to reach colleges and universities. Their education generally does not reflect career needs, and the capabilities they teach are not particularly well-tied to competencies needed in workplaces. They appropriately defend their liberal art traditions, and these are important ones, but that does not mean they cannot offer more career-related skills in addition. Their degrees are now the determinant, *de facto*, of workforce success, but these degree credentials are not well-linked to workforce realities being taught. The result is a growing sense of frustration for students, employers, and the public.

What could universities do to better prepare its workforce for advanced manufacturing in particular? (Bonvillian & Sarma 2021:127-129). Universities need to add content to their curriculum for the advanced manufacturing technologies, including the technologies delineated under heading 3 above. To summarise, universities can play a key role in organising a better delivery system for workforce education across education institutions and for employers, in developing online course materials and platforms where they can be offered, in delivering courses and content to meet higher end manufacturing technical education, in developing lifelong learning programmes, and on improving the quality of teaching and education in teaching technical material.

For example, the development of education content for higher end technical and engineering skills will likely fit a university role, while technician level content development will likely continue to be the role of America's system of two-year community colleges, as well as employers. The actual delivery of technician content will similarly belong more to community colleges, while higher end technical skills will be a college or university role. However, in new, advanced technologies like digital production or the IoT, the content will overlap, with engineers and technicians needing to understand these evolving fields. There can therefore be a university role in reaching both workforce segments. Both community colleges and universities will increasingly be offering certificates to supplement their degree programmes to scale up to meet growing needs, in part through online materials. Colleges and universities are already deeply involved in online offerings. Two leading platforms are Coursera and edX: Coursera, as of 2020, is offering some 4,500 courses from over 200 educational institutions, while edX offers some 3,000 courses from over 145 educational institutions (Bonvillian & Sarma 2021:127).

Online platforms and the courses and elements posted to them may require a university lead but will need to be tied to community colleges and industry, which will be major users. The MOOCs (massive open online courses) from universities are already increasingly focused on workforce education content – that is where the demand is. Universities are now the major developers of online workforce-related education in the US and that role could grow, making universities increasing relevant to workforce needs. Groups of MOOCs that offer career-related certificates that can be completed in a year or less, appear to be key to the future of online education.

Organising a delivery framework across institutions and skill areas could also be a university role. Take the National Science Foundation's Advanced Technology Education programme (NSF n.d.) as an example. While the programme funds go predominantly to community colleges, universities are often part of their programmes, assisting on coordination, curriculum, and online offerings. Universities could also help to assemble the consortia

of employers with whom they are already working on research, that will be needed for advanced technology workforce education efforts. With ongoing technical change in the workplace, lifelong learning will increasingly also be required. Organising this into a system could also be largely a university task. Research on and testing optimal teaching models and applying lessons from learning science, particularly as online education grows and creates blended learning opportunities, could also be a university task. There are therefore critical roles that universities can fulfil in workforce education. Some universities will resist, but many are starting to enter these roles.

The great bulk of American HE is provided by state university systems, not by private colleges. These schools were initially funded as 'land grant' institutions with the revenue from federal land sales as the country was being settled. This tradition supported very practical institutions, focused on occupational needs like agriculture and mechanical arts. Therefore, asking state universities to focus on their practical roots is not a too difficult step (APLU 2017). These schools in particular are already engaged in the manufacturing institutes, and increasing their workforce role could be workable. In addition, there is another compelling force operating on universities to move in this direction. Their traditional university student base of 18- to 26-year-olds is a fading demographic in the US. Unless universities embrace new roles, including workforce education and lifelong learning, a significant number will lose their tuition base and fail (Bonvillian & Sarma 2021:136-137).

The US is facing a shortage of skilled manufacturing workers also because of demographics. The baby-boomer generation that has dominated manufacturing jobs is starting to retire at a rapid clip – there will be over two million manufacturing jobs opening in the coming decade through retirements alone (Deloitte and the Manufacturing Institute 2018:3 of 20), and these jobs are requiring increasing skills, as digital production and forms of advanced manufacturing gradually enter the workplace. There is a need for a new kind of worker – not a full engineer, but above the technician who is tied to a particular machine. This technologist position is for those who are already trained in hands-on technical skills, and who received additional education to understand the basics of production processes, systems, supply chains, and management. It can fill a gap between engineers focused on design, and factory floor technicians trained for their machines, to be flexible – both hands-on and systems-oriented, able to organise and run new information-based production systems (Liu 2020).

To these overall 'why' skills can be added the new advanced manufacturing 'how' skills such as robotics and 3D-printing for digital production. It could be a cadre educated to introduce advanced manufacturing. While European apprenticeship systems can train these 'cell leaders' to run factory operations, the US lacks an apprenticeship system (Bonvillian & Sarma 2021:177-206).

However, the colleges and universities, working with employers and community colleges, could create this new applied technologist category, filling a skills gap in production operations. Additionally, some universities are already starting to train for these new skill sets (cf. for example, technologist programmes at Wichita State University, Engineering Technology B.S. degree [WSU n.d.] and Lorrain County Community College [LCCC n.d.]). These new high-skilled, flexible manufacturing technologists will be needed to implement advanced manufacturing.

An Emerging University Role

US manufacturing has been in trouble, facing a series of problems: Low productivity rates, low investment rates in capital plant and equipment, a thinned-out manufacturing ecosystem, production scale-up difficulties, a gap in its R&D support for production technologies, a failure to regard manufacturing as part of the innovation system, and a systemic social disruption from manufacturing's decline. Advanced manufacturing is poised as a possible answer to these challenges. Its emphasis on innovation and technical advance could help to restore efficiency and higher productivity, enabling US manufacturers to better compete with lower-cost Asian producers. To that end, the US has embarked on supporting 16 new AMIs to bring its innovation system onto the manufacturing challenges for more 'manufacturing-led' innovations. These institutes combine companies, universities, and government with a focus on manufacturing technology development and supporting workforce education.

What could the university role be in these developments? Universities were involved in designing this new approach, and are actively involved in the new manufacturing institutes, both in their administration and their technology development research. In addition, American universities could play a growing role in workforce education, including manufacturing. This role could include, as detailed above, organising the delivery frameworks for workforce education, supporting online courses, platforms, and technologies, the delivery of higher end technical content, supporting lifelong learning systems, and researching learning science to improve content delivery.

What is the relevance of this recent US experience to other nations, including less developed nations? The manufacturing institute model is a potentially replicable one. The task in getting to advanced manufacturing is not developing new science for breakthrough technologies relevant to manufacturing. It is much more about taking existing and emerging technologies that are now accessible – in such areas as robotics, digital production and 3D-printing – and translating them into production systems. It is not so much a science task, it is largely an implementation task. That

means that other nations that want to be competitive in manufacturing could experiment with the manufacturing institute model that has evolved in the US, with universities playing a key role. As discussed, this model brings together key actors – industry, universities, and government, both national and regional – and has them combine forces on adapting new technologies to production to improve its efficiency and lower costs. In addition, advanced manufacturing will only be adopted, as noted, if workforces are ready to implement it. Universities, again working with the same mix of actors, including other educational institutions, can join forces to enable new workforce education systems. In summary, while the US is a developed nation with a strong R&D system, its manufacturing institutes and supporting workforce efforts are instead focused on applying and implementing new technologies that are already largely available. This means those models are available to others to modify and pursue.

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Higher Education: Collaboration between Universities

Chapter 4

The Role of Partnerships in Preparing Open Distance E-Learning in South Africa for the 4IR: A Case Study

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Introduction

The concept of the 4IR (Fourth Industrial Revolution) is gaining currency in numerous sectors including HE (higher education) (cf. for example, Van Heerden & Goosen 2020; Grinshkun & Osipovskaya 2020). The WEF (World Economic Forum) describes the 4IR as a combination of different technologies blurring the boundaries between the physical, digital, and biological spheres (WEF 2018). The term and its implications are attracting increasing attention from policymakers, business practitioners, and academics (Oke & Fernandes 2020).

The 4IR as a technical term has its roots in the early analysis of the evolution of technology, with the aim of improving human life in different stages of history. The 1IR (First Industrial Revolution) started around 1828. During this era, water and steam power were developed to set up more systematic and efficient forms of manufacturing (Elayyan 2021). After the 1IR, a vision for a new kind of curriculum in HE began to form, with more diverse degree options and new general education programmes designed to produce the required breadth of study by offering a variety of elective courses, leading to the 2IR (Second Industrial Revolution) (Penprase 2018). The proliferation of new educational institutions and curricula after the first two IRs (industrial revolutions) provided the extended technical and managerial capacity to implement the massive expansion of the economy and manufacturing that arose in the 20th century. With the 3IR (Third Industrial Revolution), access to HE increased even more with innovations in information and communication technology (Oke & Fernandes 2020), shifting the focus to active learning pedagogies that placed a premium on collaboration, accelerated by online technologies. Educational transformations from the first three IRs provide the necessary groundwork for potential transformations in HE in the 4IR (Mezied

2016). The term '4IR' was officially announced by Klaus Schwab, the founder and executive chair of the WEF in Davos, Switzerland in 2016 (WEF 2016).

With regard to education, the exact impacts of the 4IR on society and the planet are still unknown. Penprase (2018) reminds us that any educational plan for the 4IR must be built upon the results of the 3IR and its development of online instruction. This development has been accelerated by the Covid-19 pandemic that hit the world early in 2020 and made on-campus HE impossible for several months. New online distance education approaches to teaching and learning were needed as it was important to note that digital education is more than a purely technical concern, as online environments are changing the dynamics of how teaching and learning occur.

A well-developed 4IR form of HE will ensure that students will graduate into a world that they can help shape with the needed skills for the 4IR and the 21st century. These are strong social and collaborative skills, the ability to teach, and information and technology skills (Selamat, Alinda Alias, Norris Hikmi, Puteh, & Hamisah Tapsir 2017; Oke & Fernandes 2020). Oke and Fernandes (2020) conclude that the most important skills are the so-called four Cs: Critical thinking, collaboration, communication, and creativity. Yusuf and Busthami Nur (2019) add the importance of problem solving to the list. According to Woolf, Lane, Chaudhri, and Kolodner (2013), lecturers in HE need 21st-century skills that will assist students with self-direction, self-assessment, and teamwork. Waghid, Waghid, and Waghid (2019), as well as Dennis (2020), refer to lifelong learning – rather than completing a single qualification – as a vital skill for the 4IR. These skills were further highlighted in the 2019 Horizon Report, which identifies a demand for digital skills and fluency (Alexander, Ashford-Rowe, Barajas-Murphy, Dobbin, Knott, McCormack, Pomerantz, Seilhamer, & Weber 2019). Other skills are self-efficacy, autonomy and agency, self-motivation, creativity, communication and cooperation, and reflection, as well as a stronger focus on learner-centred, lifelong learning (Alexander *et al*. 2019; Ehlers & Kellermann 2019; OECD 2018; Redecker & Punie 2017).

However, for HE to provide future generations with the right skills and knowledge, an important question must be answered: How can HE institutions ensure that lecturers and students have these skills? One way is through partnerships between IHEs (institution of higher education), as a partnership 'encapsulates the belief that individuals and organizations can achieve more by working together (in partnership) than they can by working individually' (Dhillon 2009:687). Each partner contributes different merits that strengthen the alliance and make them all the more competitive. Partnerships can take many forms. One type of relationship between universities is driven by the professional development of staff members.

The purpose of this chapter is to explore how a partnership between two universities supports academics who are developing ODeL (open distance e-learning) in South Africa, with the 4IR in mind.

The Fourth Industrial Revolution and Partnerships

The South African DHET (Department of Higher Education and Training), in its Second Research Colloquium on the implications of the 4IR for post-school education and training (DHET 2019), acknowledged that the hallmark of the 4IR is exponential growth and rapid change, making it imperative to update curriculum content at an unprecedented rate to match the rapid tempo of scientific and technological advances.

A more responsive curriculum places an extremely high premium on faculty development and curriculum renewal (Penprase 2018). In the future, academics and students will never complete their education, but must constantly engage with their colleagues and outside experts to renew and update their skills (DHET 2019). To enable university staff to maintain their expertise based on the latest discoveries and technologies, more proactive and creative forms of staff development are required (Gleason 2018). One creative way to build staff capacity is setting up international partnerships between universities. Besides the obvious enhancement of capacity gained by exchanging knowledge and experience, partnerships offer access to innovations that may not be locally available, such as the use of the latest technologies in ODeL (Van den Berg, Joffe, & Porto 2016). Studies on the international cooperation between universities have shown that it is a powerful tool for academic development (cf. e.g., Berland, Richards, & Lund 2010; Sutton, Obst, Louime, Jones, & Jones 2011; Knobel, Simões, & De Brito Cruz 2013; Mayo 2014). Despite the existence of the above and numerous similar studies on international partnerships and collaborations, there is a lack of research into international collaborations intended to build academic capacity to prepare ODeL institutions for the 4IR. This chapter makes a contribution to this field.

The South African Context

The emergence of the 4IR, accelerated by the Coronavirus pandemic, has brought with it a rapid digital transformation in the HE sector. Changes in HE are therefore even more necessary than before and the challenges ahead must be considered to ensure effective, efficient, and immediate transformation (Suganya 2017; Abdulrahim & Mabrouk 2020; Mhlanga & Moloi 2020). However, despite the advances in technology, the HE sector has been reluctant to adopt it to facilitate teaching and learning (DHET 2019). Moreover, the use of technology has been predominantly limited to an instructional approach

in which teaching is facilitated with a personal computer and electronic teaching materials. However, as Oke and Fernandes (2020) argue, the use of digital technology, underpinning the 4IR goes beyond the use of computers and e-materials and should be compatible with a learner-centred approach for it to effectively enhance students' learning experiences. A recent South African study found that the HE sector is still unprepared for the 4IR, but that there are opportunities to harness its potential (Oke & Fernandes 2020).

UNISA (the University of South Africa), which provides the context for this chapter, recognises the realities of an ageing cohort of academics, the slow pace of transformation in the academic professions, the rapidly changing needs of students, and the new demands of the workplace related to the 4IR (Ng'ambi, Brown, Bozalek, Gachago, & Wood 2016). In an address entitled 'UNISA unpacks 4IR's future impact on higher education,' Prof Narend Baijnath, the CEO (chief executive officer) of the CHE (Council of Higher Education) in South Africa at the time, encouraged UNISA as a provider of ODeL to be fully aware of its role in society, and to deliver quality teaching by constantly adapting to the technological developments needed for the 4IR. He maintained that UNISA is the most important university in the country – not only because of its size, but thanks to its reach and the crucial role that it plays and has played historically in advancing social justice. Because it offers distance learning, UNISA can reach many students on the margins of society, including those who were disadvantaged in the past because of apartheid. In Baijnath's view, tertiary institutions should reskill or upskill to future-proof people's jobs and allow employees to do away with old technologies to better serve their communities. He warned, however, that traditional methods of teaching should not be rejected out of hand because the 4IR imposes certain limitations on HE (Baijnath, cited in Ravhudzulo 2019).

Although changes in the HE sector have been slow and inadequate (Gleason 2018; Mhlanga & Moloi 2020), the pandemic required of lecturers to gain the digital skills necessary to teach their students. The need for capacity building is therefore more crucial than ever.

The Unisa-University of Oldenburg Partnership

The success of ODeL teaching, learning, and research at UNISA, as the largest ODeL university in Africa, is largely dependent on trained, competent, and capable staff who can offer programmes within an ODeL context. To address the need to build academic staff capacity, UNISA signed an agreement with the Carl von Ossietzky University of Oldenburg in Germany, a young and innovative institution (established in 1973) which, according to its website, aims to find answers to the major challenges society faces in the 21st century. The University's C3L (Centre for Lifelong Learning) offers an online,

customised, graduate-level CAS (Certificate of Advanced Studies) in online teaching and learning to its staff as part of its international Management of Technology Enhanced Learning Master's programme (Universität Oldenburg 2021). This certificate feeds into UNISA'S Master of Education (MEd) in open distance learning, which accepts credits earned in the CAS. The CAS provides customised support to UNISA staff in developing the necessary skills and competencies to implement flexible and media-supported curricula and educational projects and programmes. The fully online programme is based on a systems view of education and prepares students to strategise and organise technology integration and transformation within their educational system and across the student life cycle, from curriculum planning and development to module delivery and evaluation. The programme draws on an international network of leading scholars and researchers in the field of ODeL who are skilled in the latest technologies in online teaching and learning.

The University of Oldenburg-UNISA programme follows a holistic systems approach built on the humanistic learning theory, where willpower and direction are determined by the student. Humanistic learning theory embraces academic learning, intellectual and personal growth, and the development of needed skills (Johnson 2014). Primary contributors to humanistic learning theory include Combs, Rogers, and Knowles, who all view self-directed learning as most facilitative of growth (Tolan 2017).

The University of Oldenburg-UNISA programme focuses on academic and professional staff capacity building in ODeL, which speaks to UNISA's mandate to respond to societal, public, and private sector needs, and ODeL as a way to provide the mass education needed in South Africa and Africa. The programme was developed in response to the growing need to advance excellence, innovation, and leadership in ODeL teaching, learning, and research at UNISA (UNISA 2018). It is intended to increase the national and international recognition of UNISA's contribution to ODeL theory and inform ODeL practice and policy development. The programme trains staff in ODeL pedagogy, policies, theories, technology, ethics and quality, and change and management skills, with a strong emphasis on research and an awareness of international and transnational issues in the field.

Since many academics are subject specialists and do not necessarily have the relevant educational background to teach online, the project envisages a growing ODeL teaching and learning capacity. To stay abreast of the latest pedagogies, technologies, and trends in ODeL at UNISA, the initiative, based on the partnership is grounded in the need to develop academics holistically to ensure that they can fulfil all the roles of a university (teaching, research, and social engagement). At the same time, the staff are engaged in dedicated, purpose-driven initiatives to build, maintain, and sustain cohorts of capable students who are ready for the challenges of the 4IR.

Theoretical Underpinning

We live in a knowledge society, which means that our lives focus on creating, communicating, and applying knowledge networks. According to Schutte and Du Preez (2008), knowledge networks imply a relationship between a number of actors and resources in which knowledge is captured, transferred, and created for the purpose of creating value. This study is therefore underpinned by connectivism, which involves making connections (as learning activities) and moving learning into the digital age (Siemens 2005). Learning takes place because and by means of connections that occur between humans and between humans and technology (Downes 2007). Connectivism is driven by the understanding that decisions are based on rapidly altering foundations and that new information is continually being acquired (Siemens 2005). Siemens (2005) and Downes (2007) developed this relatively recent pedagogical theory to understand learning in a digital and connected world. The connectivist learning theory has had an impact on teaching and learning practices, making knowledge distribution possible to all network members (Van den Berg 2017).

The instructional theory used to design and deliver the course modules for the CAS is based on the PAH (pedagogy-andragogy-heutagogy) continuum, which has a strong focus on building students' capacities and skills as self-directed and self-determined learners, moving them from passive forms of learning (pedagogy) to more active, learner-centred, and learner-driven learning (andragogy and heutagogy) (Blaschke & Marín 2020). A key aspect in the PAH continuum is learner control, suggesting that within heutagogy, which can be regarded as an extension of andragogy, the learner has developed control over using the affordances provided by modern technology and increased access to information and the sharing of information (Blaschke 2019). This instructional approach aligns well with a humanistic approach, as well as with the South African context, specifically in developing lifelong learning skills as part of the country's National Qualifications Framework (Kanwar, Balasubramanian, & Umar 2013).

Methodology

Working from an epistemological connectivist position, a narrative research approach was used in this study (Henning 2004). According to Lieblich, Tuval-Mashiach, and Zilber (1998), narrative research uses or analyses narrative materials. Webster (cited in Lieblich *et al.* 1998:2) identifies a narrative as a 'discourse, or an example of it, designed to represent a connected succession of happenings.' Data are regarded as socially constructed. Narratives provide the narrators with the opportunity to reflect on and discover their inner

selves and share their experiences over a period of time (Clandinin & Connelly 2000:16).

Given the advantages of narrative research in terms of the aims of this research, the case in this study was the first cohort of academic and professional staff (hereafter referred to as participants) who were enrolled in the programme and were completing their third module at the time of the research. The participants were asked to write a brief narrative of their experiences of the CAS. This was an open question to determine the benefits of the programme and possible challenges they experienced during their course of study. The 17 students who were enrolled were asked to write down their experiences and send this via e-mail to the researcher, and 13 narratives were received.

In addition, course evaluation feedback on the impact of the certificate on their professional environment was analysed and included to supplement the participants' narratives. The responses received were as follows: Principles, theory and practice of TEL (Technology-enhanced Learning): Four evaluations; Learner Support in TEL: Four evaluations; Design of TEL Environments: Six evaluations; and International and Transnational Education Issues in Technology-enhanced Learning: Four evaluations. Two participants were from student support services and the rest were from academic departments in various colleges of the university and were thus directly involved in teaching. Their experience in the online teaching environment varied from three to 18 years.

To analyse and interpret the data, the six-phase thematic approach of Braun and Clarke (2012) was used. The study had ethical clearance and was guided by the three fundamental principles of ethical research: Beneficence, respect for an individual, and justice (Markham & Buchanan 2012). Trustworthiness was adhered to by following the principles of credibility, transferability, dependability, and confirmability (Lincoln & Guba 1985).

The Content of the Online Teaching and Learning Certificate of Advanced Studies

The certificate consists of four fully online semester modules, to be completed over a period of two years. The focus of the four modules is as follows:

Principles, theory, and practice of technology-enhanced learning

This module focuses on the history and evolution of distance education and technology-enhanced learning. Social and political/economic factors, theories, learning and teaching models, technology and media innovations, institutions and systems, and major writers are critically examined. A variety

of technologies are used to support the development of foundational skills and a personal learning environment that are integral to current practice.

Learner support in technology-enhanced learning

This module introduces the theories and concepts of support for learners in technology-enhanced learning environments. Various types of learner support are examined. Management issues to meet learners' needs and serve special groups, and evaluation and applied research are also covered.

Design of technology-enhanced learning environments

This module addresses using digital media in different educational settings. It looks at the psychological processes of perception, understanding, and learning when using educational technologies, with a focus on multimedia and instructional design for online learning systems. Hands-on experience with several multimedia applications is provided. Topics include collaborative learning technologies, open educational resources, the impact of multimedia on learning outcomes, methods of multimedia evaluation, quality assurance, and the project management of e-learning initiatives.

International and transnational education issues in technology-enhanced learning

This module examines the development and current landscape of global ODeL in developed and developing countries. Key topics are cross-border partnerships, emerging business models, academic quality, cultural and linguistic opportunities and challenges, and the innovative packaging of content. Additionally, the module compares and contrasts key global professional and international associations, the resources offered by these organisations, and their diverse roles in promoting internationalism, global trade, and the quality assurance and management of global educational services. A major theme of the module is providing examples and case studies for comparative analyses from a variety of ODeL providers in developed and developing countries.

Course Design and Instructional Approach

Each course module is 15 weeks in length, with 12 weeks for course delivery and instruction and three weeks for students to prepare a final portfolio for assessment. The modules are designed to meet the needs of working adults, with each module requiring 10 to 15 hours of study time weekly. In addition, the modules are customised for UNISA and the South African context, specifically by using case studies, research, and examples that are applicable to this university.

The modules are delivered using C3L's online learning management system, C3LLO. The course content and discussion forums are also available

on an app that allows students to have content and discussion topics available offline. As the course modules are entirely online, face-to-face attendance is not required. Discussions are mostly held asynchronously, with learner support offered both synchronously and asynchronously. All course materials are available as OERs (open educational resources) on the C3LLO platform.

The courses are presented by world-renowned academics. Each course has a primary instructor and a mentor, and in most, a scholarly expert visits the course. This approach gives the students the opportunity to learn from and engage with an international body of staff and a global network of professionals and scholars in the field of ODeL.

As indicated earlier, the instructional theory applied in the course modules is based on the PAH continuum. The students complete learning activities that are assessed as a pass/no pass. This approach gives students an opportunity to recover from a failed assignment and receive formative feedback from the instructor, which helps them improve their submissions throughout the semester. In addition, the instructors offer the students a choice of assignment topics and sometimes of assignment approaches, allowing them to incorporate their own interests and professional context in responding to the assigned activity. The results of the learning activities are then fed into a final portfolio, which is the student's primary form of assessment, and developed online (Blaschke & Marín 2020). This form of authentic assessment gives students an opportunity to critically reflect on their learning experiences and to organise and showcase their accomplishments and acquired skills. The instructors work closely with the students, scaffolding their interactions, and encouraging self-direction and self-determination.

Findings and Discussion

During the data collection and analysis process, the following themes emerged. They are discussed below:

- Experiences of online teaching and learning and related technologies.
- Student support.
- Collaboration.
- Research.
- Application in professional practice.

Experiences of Online Teaching and Learning and Related Technologies

Participants had different experiences of the knowledge and skills in online teaching and learning that they had gained and the technologies they were exposed to. One participant, who had not studied in an ODeL environment before, remarked: 'This is the first time I'm studying anything online in distance

education, and that on its own has been and is a wonderful but challenging experience.' Another inexperienced lecturer participant wrote: 'I am fairly new in academia; this is my third year. A lot of literature resonated with my own situation and made me realise that UNISA benefits a great deal by having lecturers who are schooled in ODeL principles.' Many of the narratives referred to the exposure to different technologies, in some instances in the South African context. For example, one participant stated: 'I gained insight in the history of ODL theories, practices and research skills. I was able to develop insight and awareness of the importance of the dire need for open distance learning within the South African context and how best the knowledge gained can be used to enhance the required teaching and learning skills with the goal of offering the necessary support to students with better focus. I experienced the course as very critical in empowering and preparing us as upcoming academics for the challenges of the use of technology in facilitating teaching and learning, as well as how to address the societal inequalities, including the current curriculum transformation demands.'

Further references to technologies included the use of multimedia resources, exposure to online learning platforms, knowledge of OERs, MOOCs (massive open online courses), the flipped classroom, and different tools to enhance learning in an ODeL context. With reference to the application of knowledge and skills gained, a participant stated: 'I was able to implement some of these tools in my modules and my view on teaching has changed significantly.' This means that participants were able to transfer the knowledge and skills to their own teaching environments, to the benefit of their students.

The participants also showed their appreciation for the opportunity to study at an international institution and to learn more about technology-enhanced learning. One referred to 'a deeper understanding of online learning and the underpinning theories,' while another participant referred to the students he was teaching: 'The programme has improved my online teaching and learning knowledge to teach our students.' Another participant wrote: 'I found that the course through the University of Oldenburg has really set me up as both a scholar and practitioner in open distance e-learning. In working through the modules, I have come to understand the major theories that underpin and inform distance learning and use these to reflect on my own teaching at a HE institution.' The findings above concur with those of Selamat *et al*. (2017) as well as Oke and Fernandes (2020), that the skills needed for the 4IR are, among others, information and technology skills and the ability to teach others.

Student Support

Student support was regarded as important, as eight students mentioned that the certificate had highlighted how this could be improved. One participant wrote: 'I have learnt a lot and would like to put some of the elements of learner support and striving to be student-centric into practice for the benefit of students and the institution.' Another participant commented: 'What is most interesting for me is the aspects of learner support, which as far as I am concerned is a weak area…This has made me interested in wanting to design a framework for learner support in my modules.'

The participants mentioned that they had learned about various forms of student support and what could be done at their institution to improve it. One of them stated: 'The course helped me to understand our students and how they can be supported.' In this regard, Waghid *et al*. (2019) refer to lecturers needing to support their students in gaining lifelong learning skills. Furthermore, Woolf *et al*. (2013) refer to the skills students need to be taught by lecturers, such as self-direction and teamwork.

Collaboration

The theme of collaboration on different levels was interesting. It seems that the certificate created an awareness of how participants could work together. Although there are diverse descriptions of what collaboration entails, it can be defined as constructively working with others (Knight & Yorke 2004) and working in a group to achieve a common goal, while respecting each individual's contribution (Ellis & Han 2021). Regarding collaboration with peers, one participant wrote: 'I will definitely be considering collaborations with fellow students in future,' and another stated: 'The course creates awareness of existing research opportunities and possible peers' collaborations and created interaction opportunities with other senior scholars in the field of ODeL I was exposed to in this course.' This finding is supported by Oke and Fernandes (2020) as well as Yusuf and Busthami Nur (2019), who point out the importance of collaboration and teamwork as skills needed for the 4IR.

A few participants showed their appreciation for the opportunity to collaborate and showed a desire to share what they had learned. They were positive about their connection with colleagues at Oldenburg University. As one indicated: 'The lecturers in the course were excellent. This was indeed modelling distance education. We interacted with them as if we have met them. They were very supportive and skilled.' Another participant reported that she was able to interact with her classmates and that the connection with her instructor and visiting experts gave her a good example of distance education practices in the internet space.

Research

The fact that participants mentioned research in their narratives, shows that they were interested in the scholarship of teaching and learning by writing down the knowledge and skills they had gained from their experience. One participant mentioned that he was involved in two research projects related to his studies at Oldenburg University, while another mentioned that 'the course creates awareness of existing research opportunities.' Another mentioned that she had 'submitted a draft ODeL article to a colleague,' while two participants indicated that they had submitted papers to be presented at an ODL conference.

Referring to the exposure to research in the programme, a participant wrote: 'The cutting-edge research that we were exposed to in this course already provided me with ideas on how to approach research, as well as ideas gained from interacting with our guest lecturer who is an expert in ODeL student support.' The research that participants were either planning or had conducted, relates to the critical thinking and problem-solving skills needed for the 4IR, as mentioned by Yusuf and Busthami Nur (2019).

Application in Professional Practice

The students noted numerous opportunities to apply their newly acquired knowledge within their professional environments. The ability to apply knowledge to unique environments is an important indicator of student competence and capability, one of the desired outcomes in self-directed and self-determined learning. Examples of participants applying their knowledge included the following: 'The course has been very useful for me. It made me confident to represent my university. I am now well informed about the history of distance education and what it is all about, specifically within our own socio-political context. More importantly, I have developed empathy for my students as an academic. Lastly, in my new role as a curriculum transformation specialist where I am supposed to guide academics on curriculum transformation, I am confident that I will perform this role as I know what to do when teaching and learning in distance education;' 'I am already using the information gained in this module in writing my new study guide which will be offered next year;' and 'I will incorporate new knowledge into my subject-related research. I will be improving my feedback to students.' Another participant, who was teaching in the College of Law, said, 'This course, and the certificate as a whole, has improved all aspects of my performance. My own teaching has improved. I will be starting research in online teaching and learning in South Africa, as directly related to my field. A rich body of work exists on legal education, but no one has written on TEL in South African legal education. I hope to take the gap and publish first before

anyone else is inspired by their experience of remote teaching as a result of the pandemic. Also, I am inspired to complete a PhD in TEL, not law!' The latter was particularly interesting, as this participant's learning went beyond the certificate, showing the aspiration to publish and attain a doctorate in the field. In this regard, Waghid *et al.* (2019) and Dennis (2020) refer to lifelong learning, rather than completing a one-off qualification as a vital skill for the 4IR. All the participants in this study already had at least an Honours degree and voluntarily enrolled for the CAS, indicating that they possessed this skill.

Participants further indicated their intent to apply their knowledge in practice, by referring to creativity and problem-solving skills. These skills were mentioned by Yusuf and Busthami Nur (2019) as well as Ehlers and Kellermann (2019) as necessary skills for the 21st century and the 4IR. As an example, a participant said: 'The website review activity took a lot of time to think out of the box but it was very informative at the end. The nature of the activity required problem-solving and enables deep learning. I will definitely be using this type of activity for my students.'

Conclusion

The purpose of this chapter was to explore the possibilities of a partnership between two universities to support academics in ODeL in South Africa, with the 4IR in mind. The findings show that partnerships have the potential to assist lecturers in gaining the necessary skills needed in HE for the 4IR. Online teaching skills and the use of appropriate technologies are necessary for important skills associated with the 4IR, such as collaboration, digital skills, and self-efficacy. These skills entail a connectivist rather than an instructivist approach to teaching, which leaves the door open for more innovative and flexible ways of becoming. In supporting students, they are taught skills such as self-direction, lifelong learning, teamwork, and digital skills. In this partnership, collaboration on different levels played an important role and led to future research and connection opportunities with peers, internationally as well as locally. Relevant ODeL research opportunities emanated from this partnership, leading to reflection on teaching practices in ODeL. Perhaps most important was the ability to apply new skills to a different context. This partnership enabled academics to apply the knowledge and skills they have gained to their own unique contexts, including their lifelong learning, creativity, and problem-solving.

The findings confirm that the skills that academics require cannot be taken for granted and that professional staff at IHEs have to be trained in the knowledge and skills needed to teach our students, who have to be knowledgeable citizens, as the era of the 4IR will bring great changes to what is necessary to function in the knowledge society. Although the study

identified ways in which participants were able to apply their knowledge to their current practice, it did not explore the impact that the training had on their teaching. Further research is therefore needed in this area.

Lastly, the first three IRs provided evidence of profound shifts in education, which resulted in a gradual proliferation of curricular innovation and the establishment of new educational institutions. Unlike the previous three IRs, the most important effects of the 4IR on our society may be realised very rapidly, mainly because of the demand for technologies and innovation in ODeL as a result of the Covid-19 pandemic. The 4IR displays the impacts of several compounding, exponentially expanding technologies that all share the capacity for rapid change, demanding a proactive response from the educational sector to train students who will be able to leverage the opportunities provided by the 4IR. Opportunities such as the partnership discussed in this chapter should be used to reach these goals.

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Chapter 5

Intra-Africa Academic Mobility and the Fourth Industrial Revolution

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Kenyatta University, Kenya

Introduction

There is a rising prominence in the discussion around 'internationalisation at home' concerning universities, especially in developing countries being urged to put in place measures to support the continental mobility of learners, as well as creating a conducive environment to attract international students. The diversity, inclusivity, and inequalities in access to relevant technologies are experiences that need to be interrogated if African universities are to play a role in the 4IR (Fourth Industrial Revolution), and not just be pawns (Paterson & Luescher 2022). The traction of the internationalisation of education in the socio-economic development is encouraging many African countries, as well as IHEs (institutions of higher education) to embrace strategies meant to attract international students. These strategies are aimed at harnessing the full potential of the internationalisation of education and also reversing the trend of one country as an exporter of students to a host country, as it has big implications on the image of a specific institution in the home country. There are specifically efforts geared towards creating an environment that encourages institutional partnerships and attracts students to certain IHEs in specific African countries.

This chapter discusses the initiatives to promote mobility within Africa and presents findings of a case study focusing on two universities in Kenya, which are the KU (Kenyatta University) and the USIU-A (United States International University – Africa). The case study applied a mixed methods approach, involving a survey that targeted about 100 international students in each of the two universities with in-depth interviews with 15 international students at each university. A document analysis was also carried out to establish the policy environment regarding internationalisation and particularly the mobility of students to the institutions. The chapter particularly highlights the motivations and experiences of students who have chosen to study 'abroad' but within the continent, in this case, Kenya.

Opportunities for the internationalisation of education lie in the fact that there is a growing interdependence with more and more institutions on an international level, requiring to network for purposes of the sharing of evidence-based practices, to share equipment as well as to enhance interdisciplinary cross-fertilisation to solve the complex challenges facing Africa today (Zolfaghari, Sabran, & Zolfaghari 2009:2). More universities are also focusing on international productivity, quality, and the impact of publications, as this gives them an edge in the increasingly competitive knowledge economy (Liu, Simonenko, & Anisimov 2019:258). There is also an increased demand for student and faculty exchanges, occasioned by globalisation and the need to gain intercultural competencies (Hudzik 2011:8).

The need to share information and gain expertise that is not locally available, provides even more demands for the exchange of students (Zolfaghari *et al*. 2009:6). For instance, the continent is rich in mineral resources, but lacks in infrastructure development, yet not enough engineers have been trained to exploit these opportunities within the continent. Mobility and the exchange of students is one of the ways through which the skills shortages could be resolved.

There are several benefits that can be attributed to internationalisation at home, which in this case is the mobility of students within the continent. Besides gaining intercultural competencies, the students' mobility, especially international postgraduates, serves the host country with scientific knowledge. Internationalisation has been strongly linked to improved quality training research and publications, as students who move from one country to another are to increase their academic outcomes and research performances. According to Halevi and Moed (2013:4), students who attain their PhD and postdoctoral degrees from prestigious foreign universities, for instance, have been found to perform better in research and publications than those who remain in their home countries in Africa, partly because of the networks which they create. The challenge facing Africa is that the continent is predominantly an exporter of postgraduate students. Therefore, creating an environment for mobility within the continent will enhance both research output and networks of students on the continent.

It is important to note that even though there are many benefits to internationalisation in a knowledge economy, there are also challenges that are overlooked. Countries at various levels of development experience diverse and uneven benefits and challenges that arise from internationalisation. As Lee puts it, there is 'a danger in blindly promoting internationalisation, without careful consideration of its intended purposes and unintended consequences' (Lee 2013:4 of 5). African developing countries have always prided in exporting students and researchers in the hope that they would gain those skills needed in their home countries. However, more often than not, they

lose good brains in the process as the students do not return. Beneficiaries of internationalisation have been and are mostly universities in developed countries with highly ranked global universities, a pointer that the quality of education plays a major role in the inward mobility of students. Many times, students are 'pushed' out of their home country due to inadequate or inferior educational resources or conflicts that render it impossible to study at home as is the case with many countries in Africa (Nyerere 2021:56). Many students are now doing research on the differentiation of standpoints concerning host and sending countries or regions by analysing the experiences of the international students (Kondakci 2011:575-576; Li & Bray 2007:794). This chapter also looks at the experiences of students who move and study within the continent.

Over the years, mobility has been in favour of the developed countries, and even with current challenges brought about by Covid-19 (Osman & Keevy 2021:84). This is partly due to the benefits of mobility at home that include lower costs of travel and programmes, as well as relatively lower costs associated with mobility within the region and/or continent (Lee & Sehoole 2015:829). The impetus is to raise and sustain a globally competitive knowledge-based society through less costly mobility programmes that offer higher benefits to countries and institutions in Africa. To this end, there have been efforts at the continental, regional, national, and institutional levels to encourage mobility of students within the continent.

This analysis comes at a time when technologies are being deployed in different measures to support university teaching and learning. The 4IR provides both opportunities and challenges to developing countries for the provision of education. The technologies allowing students to study specific courses in institutions outside their home countries have enabled some open universities like the University of South Africa to thrive on the continent. However, these same opportunities have, in most cases, worked in favour of universities in the West who have both the infrastructure and capacity to deploy online education. Many universities in Africa and specifically in Kenya, have not been able to take advantage of the technologies guaranteed under the 4IR to improve access and quality of education (Lupanda 2020), therefore only enabling them to host students mainly for conventional contact learning.

Efforts to Encourage Students' Academic Mobility

Currently, there are efforts that encourage internationalisation and students' academic mobility in many parts of the world, also in Africa. Africa is enhancing quality education and creating an environment that attracts students to study on the continent. A favourable environment can be achieved through improving the quality of African institutions, making them attractive to

foreign scholars and students – from abroad, but also from Africa. Through this, the continent will benefit from not only improved and quality education and training, but also from having the students remaining and working on the continent. *Agenda 2063: The Africa we want* (African Union Commission 2015) is one such continental strategic framework that is advocating for quality in the delivery of education through cutting-edge research, innovation, the promotion of experiences, sharing and learning from each other, as well as the establishment of communities of practice in the education space.

Other efforts at continental level include the implementation of the African Higher Education Harmonisation Strategy. This is the 'Arusha Convention' which was originally referred to as the UNESCO Regional Convention of 1981. The convention was reignited in 2007 to facilitate the recognition of studies, certificates, diplomas, degrees, and other academic qualifications in HE (higher education) in the African states. There is also the intra-Africa mobility scheme – the Mwalimu Nyerere mobility scheme – crafted in 2007 to develop and retain high quality human resources for Africa's development (European Commission 2013:20). This scheme, like the HE harmonisation strategy and the centres of excellence, is intended to promote intra-regional student mobility among African IHEs through the provision of scholarships to Master's and PhD students to study at universities outside their home countries but within the continent.

At regional level, there is also an intra-regional African student mobility which has gathered tremendous acceptance over the past years. In East Africa, the intra-African mobility of students dates back to independence days when Makerere served the entire region (Woldegiorgis & Doevenspeck 2015:111). Some of the efforts that Kenya and other EAC (East African Community) member states are adopting to enhance student mobility, include the establishment of quality assurance units at national/ministerial and institutional levels, the establishment of credit accumulation and transfer systems, the relaxation of travel rules for students within the region, and the harmonisation of fee structures for students from EAC countries. The five EAC member countries, Kenya included, plan to achieve a unified regional HE system which would boost student access and mobility (AfriQAN 2013). The countries have consequently drafted a credit transfer system and qualifications which, when approved, would allow students to start a degree course in one institution and complete it in another within the East Africa region (Nganga 2014). So far, more than 100 universities that are members of the IUCEA (Inter-University Council for East Africa), have scrapped higher tuition fees for students from Burundi, Kenya, Rwanda, Tanzania, and Uganda to facilitate smooth movement. These are the five countries that form the EAC, an alliance geared towards economic cooperation and future political integration.

The 15 members of ECOWAS (Economic Community of West African States) have, on the other hand, outlined various areas of cooperation in education as well as a general convention on the recognition and equivalence of degrees, diplomas, certificates, and other qualifications in the member states of ECOWAS (ECOWAS 2014:1 of 7). This is after the adoption of the ECOWAS Convention on the recognition and equivalence of degrees, diplomas, certificates, and other qualifications in 2003, as an annex to the Protocol on Education and Training clearing the way for the region's Academic Mobility Scheme as from the 2015/2016 academic year.

The SADC (Southern African Development Community) region on its part has innovatively proposed the NQF (National Qualifications Framework) (Jaftha & Samuels 2017:1) that pursues the harmonisation and standardisation of education and training systems. The framework was intended to lead to the mutual recognition of qualifications within the region, in line with the SADC Protocol on Education and Training at the postgraduate level (Chien & Kot 2011:3 of 17).

Challenges Facing Students' Academic Mobility In Africa

Besides quality constraints that have to address many of the efforts to encourage mobility within the continent, there are issues concerning disparities in teaching and curriculum standards, as well as the measurement of its impact**.** Teaching is not among the assessment criteria in most of the quality initiatives, partly because of a lack of agreed procedures, standards, and measurements for excellence in teaching. A diversity of approaches is currently in use in various contexts and it is likely that research will continue to determine the definition of the overall excellence in HE, hiding the huge challenges facing the mass provision of HE, especially in Africa. According to Gollin (2013:2 of 5), the current diversity in teaching approaches and the rapid changes in international HE are complicating the process of credit transfer when students are crossing national boundaries, thus hampering the successful mobility within the continent. Altbach (2015), on the other hand states that teaching quality is seldom measured adequately, partly because the assessment of the teaching effectiveness is not easy and there are no widely accepted parameters. The standard metric that is widely used and which has been regarded as inadequate, is that of student evaluations where they give their opinions. Further, current debates emphasise learning as much as teaching and there is little agreement about how to measure either teaching or learning. There is only a handful of cases like Spain's International Campus of Excellence initiative, Ireland's Program for Research in Third-Level Institutions, South Korea's World Class University Programme, and Germany's Excellence Initiative, that also include teaching in their quality assessments. A vast majority of initiatives, however, concentrate on research-related factors

like merit in research, the innovativeness and feasibility of the proposed research project(s), and the utility of the outcomes (Wespel, Orr, & Jaeger 2013:13).

There is also a lack of adequate efforts in assessing the impact of internationalisation at institutional on continental level. This makes it difficult to allocate sufficient resources as there is no demonstrable impact due to a systematic data collection and an analysis and dissemination of information regarding internationalisation on the continent.

Additionally, the advent of Covid-19 highlighted some of the challenges that had always gone unrecognised. The various measures which were put in place to reduce the spread of the virus, including a shift to remote learning were hurried and unplanned (Nyerere 2020). Universities were forced to suspend full-time campus-based operations, such as teaching and research, which have had a disproportionate significant negative impact on students from disadvantaged backgrounds, like the refugee students and those from countries faced with conflict (Arnhold, Brajkovic, Nikolaev, & Zavalina 2020:5 of 24). The countries bordering Kenya that deliver the majority of mobile students to this country, lack the infrastructure to support online learning, meaning that for these students, it was almost impossible to continue learning during the pandemic.

Study Justification

Research has indicated that students studying abroad are facing certain challenges that can be addressed by moving them within the region and/or continent. Some of the issues identified, include family, financial, psychological, and social barriers, or feelings of social exclusion (Sanchez, Fornerino, & Zhang 2006:29). Regional and continental mobility present a solution to some of these challenges, while responding to the needs and expectations of globalisation. Increasingly, more students in Africa are choosing to study in countries other than their own, especially those who share their borders. Recognising the emerging trends in mobility within Africa, this chapter aims to highlight the experiences of students who have chosen to study 'abroad' but within the continent. It also discusses the motivations of these students to select specific IHEs.

Study Questions

This chapter wants to answer the following questions: Why do international students choose to study in Kenya, and more specifically, the specific institution they are attending? What are international students' academic experiences? What kind of support is available for international students to

interact with and access quality education in Kenya? What are the students' future plans after their studies?

Methodology

This chapter utilised both quantitative and qualitative methods to uncover the motivations and experiences of international students in Africa. A survey instrument was used to collect statistical information from 85 international students in each of the two universities, KU and USIU-A. Interviews were conducted with participants (i.e., students) by inviting those who have completed the survey to indicate their willingness to participate further. A total of 30 students, 15 from each institution were interviewed. The interviews explored similar questions to the survey (demographic characteristics, including country of origin, field of study, and degree programme), though in more detail, so as to fully address the research objectives. While the survey data were being collected, we accessed and analysed relevant documents, such as international education policy information, recruitment materials, and admission applications. The first year of this project stretched from August 2015 to May 2016. It focused on establishing contact with the relevant institutions and rolling out the survey, while the second year (May 2016 to May 2017) focused on interviewing the international students. Combined, the document analysis and interviews set the context to interpret the student data.

Results

University education in Kenya

The first university college, the Royal Technical College was set up in Kenya in 1956, and later, in 1963, became the University College, Nairobi – a constituent college of the then University of East Africa (Chacha 2004:1 of 11).

Since then, HE in Kenya has expanded tremendously. Currently, the country has 71 universities, both public and private, up from 26 a decade ago. The available resources and teaching capacity are, however, not expanding at the same pace, but the country is nonetheless working to establish minimum standards for an ongoing Credit Accumulation and Transfer System project, a process led by the country's Commission for University Education. Besides, the country has pronounced itself in various policy documents on the need to have collaborative teaching and research programmes as one way of exchanging and sharing information, facilities, and expertise in the region and beyond (Republic of Kenya 2007:96; 2013:3).

About the Universities

Kenyatta University

At institutional level, the two universities (KU and USIU-A) have prioritised internationalisation through their policies and programmes. The policy documents that guide the internationalisation efforts at KU are an internationalisation policy as well as a partnerships policy. The internationalisation policy depicts a target of at least 10 percent of the total student population. The university had, at the time of this research, not attained this target, as the proportion of international students was less than one percent. The university also has a Centre for International Programmes and Collaboration, established in 1994, which facilitates linkages and partnerships. This centre acts as a home for all the internationalisation programmes and is key in facilitating internationalisation efforts at the university.

Besides, KU has established an Intra-Africa Semester Abroad Programme which is a student mobility programme that focuses on encouraging movement of undergraduate students between African universities. The programme was started in 2012 with the signing of memoranda of understanding between KU and several partner universities across Africa to increase mobility for undergraduate students across the continent. This is because mobility is important in building networks that are very useful in future endeavours. It also opens up the student's mind to new ideas and diverse cultures, and allows the sharing of experiences and best practices.

The programme was started with the aim to address the imbalance created by student exchanges between African universities and those from outside Africa. This is regarded as unique and affordable, and is aimed at providing an opportunity to students for one semester to experience academic and social environments other than theirs, and to promote a continental collaboration while amending the challenges of high living costs and airfare to countries outside Africa that have historically inhibited the movement of African students. One unique feature of the programme which has hindered the mobility of students in the past, is credit transfer. The students take units relevant to their courses and thereafter credit transfers are effected upon the receipt of transcripts from the host university. Therefore, students do not need to redo the same units at their home university.

United States International University – Africa

As for USIU-A, the internationalisation of education is key to its existence as expressed in the university strategic plan 2015-2020. The university admits students from various countries to reflect its mission (USIU-A 2015). At the time of this chapter, the proportion of international students at USIU-A was 15.3 percent of the 6,398 total of university enrolments (USIU-A 2016). Given

that the majority of universities around the world aim at a target of 10% proportion of international students, USIU-A is certainly ahead. The university also has a dedicated international office that deals with all international student matters, but unlike the KU office which houses all international linkages and collaboration programmes, the international office at USIU-A deals only with international student matters.

Choosing to Study in Kenya

Sources of Information on Universities in Kenya

The research for this chapter revealed that international students are accessing information from a diversity of sources on the courses offered at the two mentioned universities in Kenya. Among the sources are the internet with the institutions' websites where the students access programme brochures and advertisements. Others are informed of the institutions by alumni, family, and friends. Figure 1 below shows the extent to which international students who participated in the study, relied on the various sources to get information on the programmes and courses of KU and USIU-A.

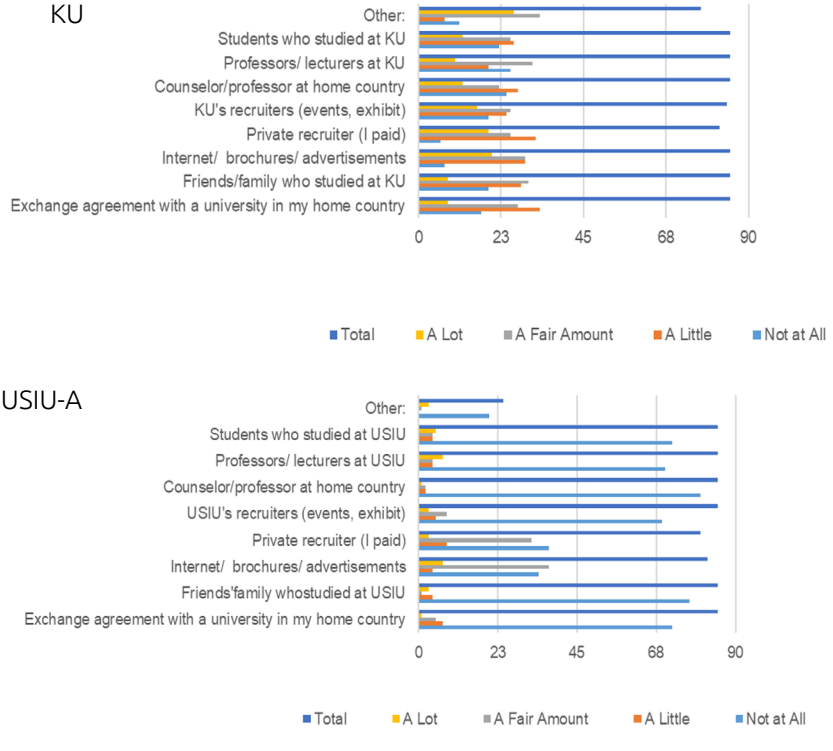

Figure 1: Extent to which international students relied on various sources of information in choosing KU and USIU-A.

Reasons for Choosing to Study in Kenya

The choice by different students to come to Kenya is influenced by diverse factors. Among those influencing factors is the proximity to home countries. Those from the EAC feel specifically that studying in Kenya is cheaper in terms of fees, travel, and living expenses.

5.4.1 Tuition Fees

Universities in the region have now categorised all Eastern African students as local students, whereas a student moving to study at any of the five East African partner states pays the same tuition fees as local students. The institutions are, however, retaining their individual fee structures. The only difference for the mobile students within East Africa is that they are not entitled to access their host country's government student loan scheme or bursaries and are expected to pay up full-cost fees. In Kenya's public universities, students from the EAC pay full tuition fees as do Kenyan students or the self-sponsored students, attending parallel track programmes. Before, all non-Kenyan students were categorised as foreign students and charged 20 to 30 percent more than the local students, depending on the university.

Generally, and in comparison with countries offering quality education in other parts of the world – Europe and North America, and closer home in South Africa – Kenya was considered affordable in terms of tuition fees and living expenses. This influenced many of the international students being interviewed as referred to below.

> 'I wanted a place where I could sponsor my education because when I came here, I wasn't sure that I could obtain a scholarship, so I wanted a place where if I would be able to raise some funds to sponsor myself if I was unable to secure a sponsorship…When you compare KU with other institutions in South Africa, you will understand that in terms of tuition, what is being paid here is less…and even when you look at the living costs here in Kenya, it is quite smaller than what is required in other parts of the world like Europe or America' (Rwandese student at KU).

> 'I chose KU because of poor educational development in my home country for so many years and I had been doing my studies in Kenya since class eight up to now. What made me want to study in Kenya also is because it is not far from home. In fact, our country (South Sudan) has joined the EAC and so there is now flexibility in terms of people's movements and big discount in terms of fees for us' (South Sudanese student at KU).

> 'I had tried one university in Namibia, one also in our neighbouring country Zambia and a few others…I was admitted in Namibia and here (KU) and so it was a matter of choice between the two. Because I am in hospitality, I chose to come here because it is not too far from home to experience a different culture and to have a different exposure from Southern Africa that would benefit industry back home' (Malawian student at KU).

> 'Before I came here, I was studying at a university in Nigeria but I had also attempted to study at other universities abroad like in South Africa at University of Johannesburg and University of Pretoria. The problem with them was high fees and a lot of paperwork involved, so I gave up, but when I tried USIU-A, I found it affordable, the application process was smooth and even the visa to enter Kenya is issued on your arrival' (Nigerian student at USIU-A).

Proximity to Home Countries

The majority of the international students at the two universities come from other African countries. Those interviewed cited proximity to their home countries, affordable tuition fees and living experiences when compared to other countries like South Africa, Europe, and North America. This confirms the reasons cited for mobility within Africa in an economic and utilitarian study (Jon, Lee, & Byun 2014:703)**.** Figure 2 below shows the weight that international students place on their reasons for a choice of the institutions of KU and USIU-A.

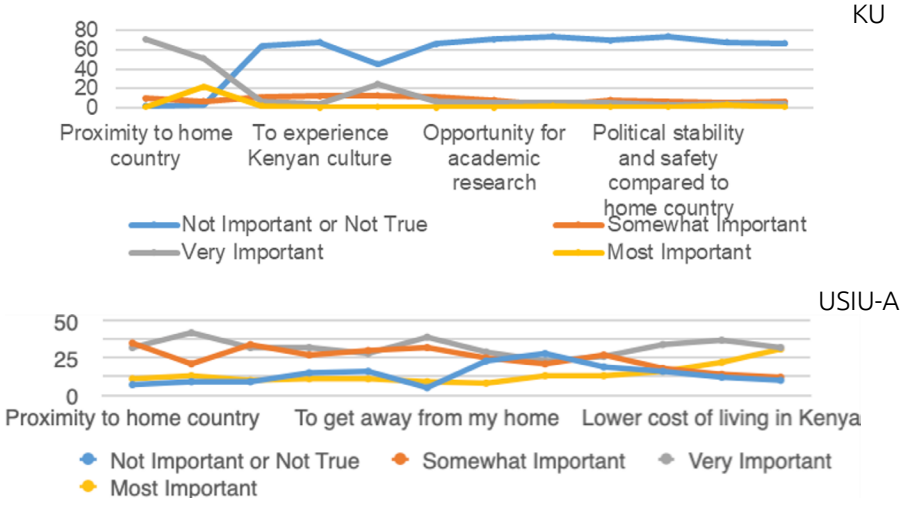

Figure 2: Reasons why international students chose KU and USIU-A

For both institutions, students considered proximity to their home country as an important factor. Many students from other African countries do not find a big difference between studying at home and studying at a university within Africa. They find a lot of similarities with their home country which help them settle faster.

> 'Us students from other African countries feel "home away from home" here. This is not really abroad…there are many similarities with my home in the way people behave in the streets, the food, the weather' (Nigerian student at USIU-A).

> 'I wanted to study somewhere outside Tanzania but within Africa to get exposure. I first considered South Africa – University of Johannesburg, but it was too expensive for me. My next option was Kenya, and when I looked at the list of good schools, USIU-A was one of them. I chose USIU-A because of diversity as I realised from their website at the time there were students from about 64 countries' (Tanzanian student at USIU-A).

> 'I did my undergraduate at home (DRC), so I decided to come to Kenya because I wanted to have another learning experience outside my country. I chose Kenya because I wanted to study in an English-speaking country and I did not want to travel far' (DRC student at KU).

> 'I just came to study in Kenya because I wanted to experience a new life outside Uganda but did not want to go far from home. Kenya is the best for me because I can go home cheaply by bus when I want to go. Also there are no issues with visas as I can use my national ID to come in' (Ugandan student at KU).

Quality and Reputation of Institutions

Research has established that quality is a major 'pull factor when it comes to attracting international students' (Altbach 2004:21). This study established that students indeed chose the host institutions in Kenya, guided by its reputation that they gathered from other sources like friends. Others got the information through web searches and used web rankings to choose the universities in Kenya. The students' choices were thus partly influenced by their perceived quality of education and access to learning resources in the two universities. Asked what they thought of the quality of education they were receiving, all the international students interviewed, agreed that it met their expectations. The students noted that they were exposed to quality tuition, learning facilities, and an internal environment, characterised by a diversity of students. Here is a snapshot of their responses.

> 'KU has a very good learning environment in terms of library facilities, both online and in hard copy and I think these are very important when one is pursuing this education…KU has a good and large repository of resources' (Nigerian student at KU).

> 'The curriculum has never been a waste of time…especially doing the course work. It is very relevant…sometimes I reflect and ask myself… what if I had not done coursework and just climb through the research programme, I would have been empty, honestly…the more you interact with the curriculum, you realise that there are so many things that one needs to know…the curriculum was more interactive…the curriculum is treated differently at this level' (Ghanaian student at KU).

> 'Here at USIU-A, I feel like I am having the same knowledge with people who are outside there, like UK, US because they are international courses' (DRC student at USIU-A).

> 'Coming here has exposed me to other ways of thinking, other ways of doing things beyond the classroom. For example, people here in Nairobi tend to be fast in pace, working hard and I think that is something that has impacted on me and I would like to apply at home' (Malawian student at KU).

Among the students interviewed, there was a general agreement that the education they received met their expectations. The post-graduate students particularly liked coursework preceding their research, which they said was not common in their home countries. The students also agreed that they had been exposed to learning resources, access to internet, equipment, and a library, things that they did not really have in their home countries. There were, however, a few cases, particularly students from neighbouring Somalia and South Sudan, who were honest to state that they had no standards back at home to compare with. This is because of the challenges they were experiencing with war and instability, running down institutions, including education. HE is thus not developed in their countries and they felt that Kenya was the closest opportunity they had at getting a university education. The country is thus playing a unique role not just in the traditional academic student mobility, but to offer training to students of neighbouring countries which are affected by war or are just recovering from war and need skills to rebuild their countries.

Students who took part in the survey, confirmed that they had learnt a lot in various fields, including general knowledge and new cultures. The knowledge they gained went beyond their professional careers as expected

of internationalisation and academic mobility. Figure 3 below shows their responses in terms of learning outcomes.

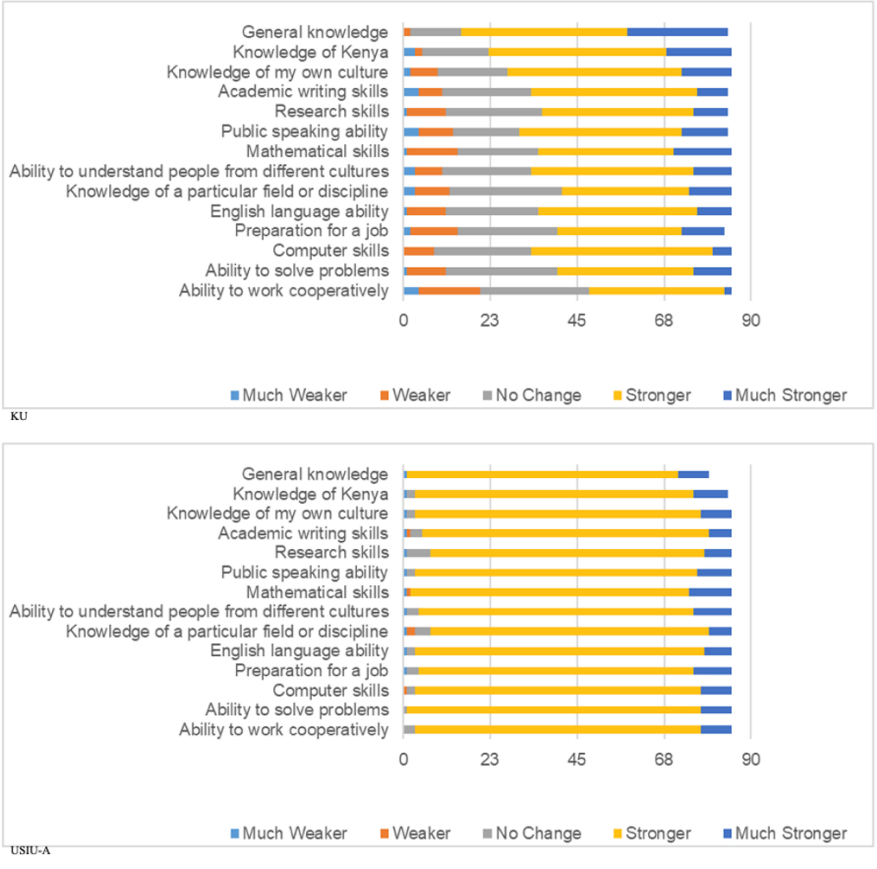

Figure 3: International students ranking of the knowledge and skills gained

Visa Application Process

The other consideration cited by students to have influenced their decisions to study at these two universities in Kenya is the visa application process. The launch of national identity cards as travel documents within the Eastern African region has made it easier for cross-border students to access education at universities of their choice, further enhancing the regional academic mobility of students. Students from countries in the EAC do no need visas, whereas those from other countries in Africa like Nigeria have an online application platform which is easy and fast to use.

International Students' Experiences

Personal Interactions

The students who participated in the study were in agreement that learning abroad brings new experiences. Studying away from home helps one to discover other people's behaviours, as well as their way of life and thinking, and *inter alia* opens the scope of analysis and comparison. However, this largely depends on the kind of interaction the students have in outside campuses. The majority of those interviewed, commended the two institutions, KU and USIU-A for the initiative to take them on tour to various parts of the country as part of their welcome and familiarisation with the country. They said this had exposed them to various sites and cultures of the Kenyan people besides the regular interaction with their peers at the universities.

The students knew well that interacting with other students – local and international (from other countries) – would give them a chance to understand other cultures, and they were making conscious efforts to gain this valuable learning outcome.

> 'I do interact with students from my home country from time to time, but I deliberately interact less with Nigerians and the reason is that these are people I know; we are from the same country, so we have some level or relationship already…I feel I need other relationships somewhere else, that is the reason...I am interested to know other people, other cultures, and learn about their experiences and how I can use the same to better my life' (Nigerian student at KU).

There were a few cases, however, where students said they felt more comfortable interacting with the students from their home countries. These students specifically referred to the language barrier, as local students chose to speak in their national language, Kiswahili. For example, one of the interviewed students said that he interacted more with students from his own country, Angola and neighbouring countries who speak the same language: 'My friends are from the Angolan community in this university and those from Mozambique because we speak the same language, Portuguese.'

There were also those who felt more comfortable interacting with other international students more than the local students. Those who were more comfortable interacting with other international students, felt that they had more in common and that the other international students would understand their circumstances better than the local students. It is interesting that many of these students would like exposure to other cultures than their own, but

were more comfortable learning these from other international students than from the local students.

Some of the Challenges that the International Students Experienced

Overall, students felt that they received good if not better treatment than their local counterparts. They felt that their concerns were attended to faster, and the university community – international student offices, students, and staff at the universities – were welcoming and ready to assist them to settle. They also referred to the opportunities provided to the international students to tour the country, opportunities not provided to local students, as an advantage they have. That notwithstanding, the international students expressed a concern over some challenges they were experiencing ranging from cumbersome application processes to inadequate accommodation, and poor student support services, as discussed below.

Language Barrier

International students faced some challenges related to social integration. One of the hindrances to this integration is the language barrier where international students cannot communicate in the dominant local languages. In Kenya, though the English language is used as a medium of instruction, Kiswahili is the national and therefore dominant language. Kiswahili is only spoken by a few countries, mainly in the Eastern African region. The majority of the international students therefore, even those from other parts of the continent, found it a barrier in socialising and communicating, especially outside campus. Generally, some international students felt excluded when their peers talked Kiswahili during group/classroom discussions. Due to the language barrier, some had been conned by vendors taking advantage of their inability to communicate in the local language, whereas others were afraid to leave their areas of residence unaccompanied due to the fear of harm or abuse.

Poor International Student Support Services

Students also cited challenges accessing student support services. Key among them was the issuance of students ID (identification) cards. The students needed facilitation to get ID cards without which they were unable to open a bank account or even register their telephone cards. The slow process of acquiring IDs also impacted on students travelling to home countries because it became difficult to travel back to Kenya the second time without a student ID card. This has put a strain on students who wanted to travel back home months after reporting even for emergencies.

> 'When I was coming, I didn't get a big challenge for visa…rather when I went back to my home country after one year, to return back to continue my studies, it has been a big challenge...because apparently, I didn't have a student's pass, it wasn't yet out, so I was rejected when I applied for a visa to come back to Kenya (Cameroon student at USIU-A).

Inadequate Accommodation Facilities

The study established that international student accommodation was not sufficient at the two universities and students were forced to hire their own accommodation outside campus. Inadequate accommodation forced the universities to come up with varied criteria in housing the international students. Whereas KU prioritised students on short term stay in offering accommodation within the university hostels, USIU-A considered those enrolled for full-time courses for university accommodation. The university goes further to explain who qualifies for university accommodation as the undergraduate students taking nine credit units or more and graduate students registered for at least six units a semester. None of the two universities had an international students hostel in place which proved a challenge for international student interns of both managing rents at market rates, interaction with the community outside the university who only speaks the local language, as well as security concerns.

International students Plans after Study in Kenya

Up to 98 percent of the students being interviewed, affirmed that they would go back home after their studies. A number of them said they would go back home to develop their education institutions and infrastructure, while others wanted to go back and engage in entrepreneurial ventures. The remaining two percent of the interviewed international students said that they would continue to higher levels of education – Master's and PhD – in Kenya or other countries to the north of Africa. Studies like those by the European Union (2015:3 of 23) have also shown that mobility within the continent increases return rates to 97 percent as opposed to those who leave the continent. Many of the scholars who leave to study outside the continent fail to come back.

> 'After study, I will go back home and use the acquired knowledge and experience back home…I have learnt a lot of things here, especially in terms of research, experiences in class which I want to use to make a difference in my country…I would want to make a difference out there' (Ghanaian student at KU).

> 'My aspiration is to go back home and develop my country, using the education that I am undertaking because my country is still at a very poor standard level' (Somali student at KU).
>
> 'My aspirations are to start my own business…I am not yet sure that it would be good to do it outside my home country, whether here in Kenya or in another place because it is always easy to start and grow in a place where people do not know you' (Malawian student at KU).
>
> 'Due to the crisis back home, my aspiration is to become a humanitarian aid worker but before or later on I may venture into entrepreneurship or politics' (Somali student at KU).
>
> 'After study, ideally, I would like to get a job and if that is not fast coming, I would volunteer, do some internships…and then pursue a Master's degree. Right now I am thinking of Europe' (Nigerian student at USIU-A).
>
> 'I study business, so when I go back home, I will start a business. I will use the international networks I have created here at USIU-A to spread my business to other countries like Nigeria where my best friend comes from' (Cameroonian student at USIU-A).

Discussion and Conclusion

Whereas universities relied more on the physical mobility of students over the years, the Covid-19 pandemic has caused several disruptions to HE, forcing universities everywhere into a crisis mode overnight. Responding to such an abrupt and multidimensional crisis has been a challenge not only to governments but also to the universities. The pandemic set in at a time when Kenya's HE sector was already facing serious challenges, which further compounded the challenges they have faced in responding to this crisis. The impacts of the pandemic made the universities in Kenya develop new adaptations and interventions, some of which led to monumental shifts which could have taken years, if not decades to realise. The requirements of these responses brought to fore the essence of strong local, regional, and international collaborations (Lues, Padayachee, & De Jager 2020).

The effect of the pandemic containment measures including social distancing, called for new digital oriented teaching, learning, and research skills that a majority of university students and lecturers were not previously exposed to. The adaptation has been slow, as most students, especially those from countries neighbouring Kenya that are in conflict would not keep pace. It is expected that with strategies adopted to keep students both local and

internal, learning will accelerate the universities' participation in the 4IR. Participating in the 4IR as key players, will assure diversity, quality, and equity in access to relevant HE both for the local students and the international students who want to study in Kenya.

The continental regional bodies, national agencies, and IHEs are already pursuing various initiatives of student mobility inside Africa. At a continental level, internationalisation initiatives have received support of the AAU (Association of African Universities) and the AU (African Union) Commission with the AAU overseeing the AfriQAN (African Quality Assurance Network) and the Europe-Africa Quality Connect pilot project (Shabani 2013:3). Institutions in Kenya draw their policies and actions from the IUCEA which is pushing the harmonisation of degree programmes in the region, and the African Agenda 2063 framework which encourages and promotes the sharing of experiences and learning among African countries. Collaborations are thus encoded in mounting internationally recognised programmes that can provide the experiences sought by mobile students. These collaborations, especially with the private sector and industry also became imperative during the Covid-19 pandemic. Some private sector entities supported with internet access, infrastructure, and technical capacities were needed by the institutions for containment measures.

Notwithstanding, students who participated in this study, confirmed that learning abroad brings new experiences and that they had been exposed to various cultures and different ways of thinking, which opened their scope of analysis and comparison, among others. They admitted to having their personal and career aspirations met by these international institutions. The majority of them indicated a readiness to return to their home countries, contrasting the experiences in most north-south mobilities where the best brains stay working at their host institutions.

However, this does not imply that the students did not face some challenges which need to be addressed to make institutions within the continent more attractive to international students. Some of the challenges relate to inadequate social integration where one of the hindrances is the language barrier which was indicated as an issue for those who do not speak the national language, Kiswahili. The other problem that should be addressed is to create a favourable environment for the international students regarding accommodation. The lack of international student hostels exposed them to incidents of insecurity or mistreatment when living outside university campuses. Some students also spoke out their dissatisfaction with the student support services like the slow process of acquiring student ID cards which impacted their visa processing and travel to and from home countries.

Besides, recently the students have faced some form of exclusion from learning, occasioned by the Covid-19 pandemic. The shift to online learning to limit the spread of the virus saw many students unable to connect with their institutions. The challenges included unpreparedness on the part of the host institutions to effectively teach, examine, and generally facilitate learning remotely. The infrastructural challenges discriminated against international students. Coupled with the lack of policies to support student learning off-campus, let alone in different counties, the limited access to remote learning facilities brought out inequalities against the intra-Africa mobile students. The challenges of access to technologies, if addressed in true integration of the 4IR, will ease most issues related to international student support services.

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Higher Education:
The Way Forward

Chapter 6

Rethinking Strategy and Statecraft for the Age of 4IR: Implications for Higher Education

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Introduction

This chapter[1] recognises that the age of the 4IR (Fourth Industrial Revolution) will transform the context and alter the conduct of statecraft and strategy around the world. Accordingly, we offer a set of forward-looking ideas and observations about how this may evolve, with a focus on new thinking about the looming emergence of the 'noosphere' and 'noopolitik' – concepts we will clarify below. We then identify some prospective implications for HE (higher education) in regard to future coursework and curricula for educating professionals about grand strategy in the age of the 4IR.

Around the world, national-security and foreign-policy strategists are having difficulty adapting to the digital age as part of the 4IR. A rethinking is needed. For decades, countless writings have pointed this out – ours among them – and marginal improvements were being made. However, it is time to urge a deeper rethinking in light of new threats and other challenges to so many societies, institutions, and cultures. Neither experts nor strategists are meeting these threats and challenges well enough. Both need to improve their ability to look ahead in the best ways possible.

Advanced information, communications, and sensing technologies are increasingly available, but the challenge is not simply technological. Instead, the challenge is mainly cognitive. Adversaries everywhere – from nations to nonstate networks – are using dark new modes of political, social, cultural, and psychological warfare against their opponents: Wars of ideas, battles of stories, weaponised narratives, memetic viruses, and epistemic attacks. New kinds of cognitive warfare are being deliberately designed to confound analytic and social strengths and exploit weaknesses in individuals, institutions, and societies as a whole. Covid-related disinformation campaigns are a recent

1 This chapter is adapted from a think-piece with a similar title by Ronfeldt and Arquilla (2020a).

manifestation of this. So are many aspects of the war in Ukraine, particularly Vladimir Putin's twisting of the historical relation between Moscow and Kyiv and his attempt to justify the 2022 invasion as a mission to 'denazify' a duly elected, democratic government.

Strategists of all stripes – theorists and practitioners – remain unsettled and often baffled about how best to analyse, organise, and act amid this stormy flux. Trends and indications around the world suggest that matters may grow worse before they become better – *if* they do become better – in the coming years.

The most advisable way ahead for information-age strategists, especially in the world's capitals, is to reposition statecraft and grand strategy by merging two streams of thought: The first involves the well-known distinction between hard power and soft power; the second engages a lesser-known distinction about the geosphere, biosphere, and noosphere (the last term means 'realm of the mind,' as we clarify below). At first glance, the two streams may seem unrelated, but they are starting to come together in ways that should be recognised – the sooner the better. Doing so, reveals a new kind of information-age statecraft which we call 'noopolitik' as a successor to the traditional 'realpolitik.'

Hard Power versus Soft Power

Strategists have traditionally thought and planned primarily in terms of tangible, material, 'hard' forms of power – military forces, economic capabilities, and natural resources. They refined 'realpolitik' in the 19th and 20th centuries to express their hard-power dispositions as a mode of statecraft that emphasises seeking relative advantages through displays, threats, and uses of force. In various ways, realpolitik-type thinking and covetous campaigns for hard-power resources lay behind the European efforts to acquire colonies abroad back then, notably in 'the scramble for Africa' (Pakenham 1991).

A realisation that immaterial, ideational, 'soft' forms of power – ideas, values, norms, and battles for hearts and minds – may matter as profoundly as 'hard' forms of power started to take hold in the early 1990s, when the end of the Cold War and the relatively peaceful dissolution of the Soviet Union helped to demonstrate the potential effectiveness of ideational approaches to statecraft. Hard power played a central role in deterrence and containment strategies from the late-1940s to the 1980s, but it was the West's soft power (for example, the advocacy of democracy, free flows of information, and civil-society activism) that brought the decades of high-stakes confrontations to a successful, peaceful conclusion. Moreover, by then, the internet and other digital information technologies were on the rise, and strategists, most of all

in the US, were beginning to view information itself as a new form of power, one that favours the 'soft side' of the spectrum.

However, the American idea of soft power contained flaws. The original definition tended to treat soft power as good and hard power as bad, or at least as mean-spirited – i.e., soft power was regarded to be fundamentally about persuasive attraction, hard power about coercion (Nye 1990, 2004). However, in actuality, soft power is not just about beckoning in attractive, upbeat, moralistic ways that make the US and its allies, friends, and other like-minded societies look good. It can also be wielded in tough, dark, heavy ways too, as in psychological efforts to warn, embarrass, denounce, disinform, deceive, shun, or repel a targeted actor. Moreover, soft power does not inherently favour the good guys. Malevolent leaders – say a Hitler, a Bin Laden, or various of today's authoritarians – often prove eager and adept at using soft-power measures in their efforts to dominate at home and abroad.

Thus, while strategists and other leaders in the more democratic societies were misconceiving the concept of soft power, even inflating it into 'smart power' by combining hard and soft power (Nye 2009), they neglected to come up with a doctrinal derivative that could rival hard power's realpolitik. Indeed, many simply persisted with realpolitik, trying to modify it to suit the information age. Spread over several decades, this conceptual inertia, even complacency, has left the US, and quite often its allies and friends, at a strategic disadvantage. The American conceptual arsenal, not to mention those of its allies, is still sorely lacking for understanding about how to apply soft power. Strategists who primarily believe in hard power, have developed quite a set of concepts around it, particularly over the past two centuries – e.g., realism, geopolitics, balance of power, and realpolitik itself. A comparable conceptual arsenal has yet to be developed around soft power.

Meanwhile, various adversaries and competitors of the West and other liberal societies – from nation-state actors in Russia, China, North Korea and Iran, to nonstate networks like Al Qaeda, the IS (Islamic State), and Wikileaks – quickly learned to develop dark approaches to soft power, especially online, in order to undermine American and other democracies via political warfare and challenge their positions in the world. Thus, Moscow fielded new narratives to extol Eurasianism and deride democracy, while releasing a torrent of deception, disinformation, reflexive conditioning, and de-truthing operations. Additionally, Beijing began concentrating on developing and deploying what it called 'discourse power' and 'cognitive domain operations' as its way of influencing how people think about China and its growing reach around the world.

In short, democracy's adversaries began deploying aggressive soft-power strategies and tactics – lately called 'sharp power' (Walker & Ludwig

2017a, 2017b) – far more adroitly than ever expected, catching Washington and other liberal capitals quite unaware and unprepared during the early years of the 21st century. Nonetheless, rather than rethinking matters, leaders in Washington and elsewhere have continued to neglect their soft-power capabilities, Instead, they reverted to re-emphasising hard power and realpolitik (on this point, see especially Bacevich [2010] about America's missteps).

This state of affairs should be viewed with alarm. It should prompt an awareness of the urgent need to rethink statecraft for the information age. In our view of how best to approach the 4IR, this means shifting away from realpolitik toward noopolitik, a concept inspired by a second stream of thought.

Emergence of the Noosphere

Over the past 100 years, various scientists in Europe, America, and Russia have worked on developing a stream of thinking about our planet's geosphere, biosphere, and noosphere. Whether appearing singly or jointly, these three dimensions work as a layered set for understanding Earth's eons of evolution as a planet. Accordingly, first to evolve was a geosphere, consisting of the Earth's geological mantle. Next to evolve was a similarly globe-circling biological layer, or biosphere, consisting of plant and animal life, eventually including people. Third to grow and develop will be an all-encompassing realm of the mind, a 'thinking layer' termed the noosphere. These concepts were all in use by the 1920s, and continue to be today.

The last term emerged when French theologian-palaeontologist Pierre Teilhard de Chardin, his friend, French mathematician Edouard Le Roy, and visiting Russian geochemist Vladimir Vernadsky met in Paris in 1922 to speculate about whether, because of humanity's growth, our planet would ultimately evolve a third layer, namely an all-enveloping noosphere, a term they coined from the Greek term 'nous,' a reference to the mind. Teilhard defined it as a 'realm of the mind,' a 'thinking circuit' – in the later words of his colleague, Julian Huxley, a 'web of living thought' and 'a common pool of thought' that would lead to an 'inter-thinking humanity.' For Teilhard, it was a spiritual as well as scientific concept, whereas for Vernadsky, it was strictly a scientific concept – though both regarded it as having democratic political implications as well (Samson & Pitt 1999).

At first, the concept of the noosphere spread slowly and selectively among environmental scientists and social activists in the West. Some early believers are credited with helping to inspire the creation of the UN (United Nations), UNESCO (the United Nations Educational, Scientific and Cultural Organisation) and other 'noospheric institutions' after World War II. In addition,

the post-war period led to UN-backed covenants that reflected noospheric hopes, such as the Universal Declaration of Human Rights and the Convention on the Prevention and Punishment of the Crime of Genocide, both in 1948. Not long after, the noosphere concept attracted wide attention in Europe and America in the 1950s and 1960s, following the posthumous publication of Teilhard's books on *The phenomenon of man* and *The future of man*, as both became bestsellers. Even so, the concept still spread mostly among a narrow range of intellectuals – until the 1990s.

Since then, the rise of the internet as part of the 4IR has excited a sense across the spectrum of theorists and prophets of the information age, that cyberspace is providing a technical foundation for the emergence of the noosphere. While the concept has still not gone mainstream, it is proliferating far and wide, now at the level of online platforms and not just individuals – *Wired* magazine, the *Edge* website, Evolution Institute, and various magazines and websites associated with pro-commons social theory and social activism on the left, often feature articles supporting the concept's potential. Indeed, from a political standpoint, people and platforms on the left have shown the greatest degree of interest in the noosphere and its future prospects. Interest on the right is relatively rare. Theorists and activists on the right are deeply interested in information-related concepts, systems, technologies, and their effects, but they prefer traditional constructs such as culture, ideology, and the media, maybe even atmosphere or *Zeitgeist*, over noosphere or other futuristic notions.

Lately, various technologists and other scientists have preferred concepts that are not exactly focused on the noosphere, e.g., collective consciousness and the global brain. However, they all still descend partly from the idea of the noosphere. Moreover, future successes with alternate concepts are bound to help further the noosphere too. It is here to stay. It will continue growing in significance and popular usage.

Onward into the Future with Noopolitik

In sum, the noosphere concept provides a logical grounding for thinking broadly about policy and strategy in the information age. Furthermore, our derivative concept – noopolitik – matches up with soft power, the way realpolitik matches up with hard power. No alternative concept does this as well. By comparison, cyberspace and the infosphere are smaller, more technological domains. The noosphere is the best all-encompassing concept for thinking about information-based realms and its dynamics.

We first proposed noopolitik as an alternative to realpolitik back in 1999 (Arquilla & Ronfeldt 1999; cf. also Ronfeldt & Arquilla 2007, 2020b). However, little happened then to further its development. Ever since, other strategists

have proposed kindred concepts – notably cyberpolitik, netpolitik, infopolitik, information engagement, information statecraft, information geopolitics – yet they too have failed to gain traction. Individually, these kindred concepts vary somewhat definitionally, but what is more important is that collectively, they all represent innovative but so-far-unsuccessful efforts to improve the conceptual arsenals of strategists for dealing with information-age threats, challenges, and opportunities, in particular by urging strategists to emphasise networks more than hierarchies, and nonstate actors as much as, sometimes more than state actors.

All of which leads to two points. First, noopolitik remains a suitable proposal for reorienting statecraft in the information age. Next, even if this particular concept does not take hold, strategists had better come up with something very similar, fast, before the world's dark adversaries do irreversible harm to the US and other open societies by continuing to apply their own vexing mutations of noopolitik. At stake is the essence of effective strategy and statecraft in the information age: Whose story wins?

Taken seriously, the noosphere concept has particular implications for developing noopolitik as an approach to statecraft. The noosphere began as a scientific and spiritual concept, but it has also acquired a forward-looking political cast. Its expansion implies the ascendance of ideational and other soft-power matters. It favours upholding ethical and ecumenical values that seek harmony and goodwill, freedom and justice, pluralism and democracy, and a collective spirit harmonised with individuality. South Africa's Nelson Mandela and Desmond Tutu have served as exemplars to the world of this kind of value-driven statecraft.

Noopolitik is also better than realpolitik as an anti-war and pro-environment concept. Strategically, it implies thinking and acting in global/planetary ways while minding long-range ends, and the creation of new modes of agency to shape matters at all levels. It implies humanity coming together through all sorts of cognitive, cultural, and other close encounters. It is about the co-evolution of the planet and humanity – it therefore implies understanding the nature of social and cultural evolution far better than theorists have so far. It also means engaging nonstate as well as state actors in a quest to create a new (post-Westphalian) model of world order less tethered to the nation-state as the sole organising principle and focus of loyalty. Furthermore, it favours the widespread positioning of sensory technologies and the creation of sensory organisations for planetary and humanitarian monitoring and response purposes.

Yet, positive and peaceful as all this may seem, growth of the noosphere also implies having to deal with persistent ideational clashes and conflicts. Indeed, Teilhard, Le Roy, and Vernadsky expected ruthless struggles, shocks

and tremors, even an apocalypse, as different parts of the noosphere begin to mingle and fuse around the world. These are not implications which the founders simply tacked on, they rather stem from discerning principles and dynamics that attended the prior development of the geosphere and biosphere as global envelopes.

Proponents and practitioners of noopolitik should heed these distinctive implications, and not view noopolitik as a self-aggrandising public relations or propaganda game. When the switch to noopolitik deepens in the decades ahead, strategists will gradually figure out how different it is from realpolitik. The reason is that noopolitik requires a fresh way of looking at the world – a new kind of mindset, situational awareness, knowledge base, and assessment methodology, along with a generally more philosophical and theoretical outlook. How to look at hard power, thus realpolitik, is quite standardised by now. However, how best to understand and use soft power is far from settled. Noopolitik depends on *knowing* – and finding new ways of knowing – about ideational, cognitive, and cultural matters that have not figured strongly in traditional statecraft. As the information age deepens in the decades ahead, it will eventually be acknowledged that noopolitik is not only an information-age alternative to realpolitik, but also a prospective evolutionary successor to it (cf. Table 1 below, which compares aspects of realpolitik and noopolitik).

Table 1: Contrast Between Realpolitik and Noopolitik

Realpolitik	**Noopolitik**
Nation-state as key unit of analysis	States, nonstate actors, networks as key units
Primacy of national self-interest, sovereignty	Primacy of shared interests, mutuality
Primacy of hard power	Primacy of soft power
System as anarchic, conflictual	Harmony of interests, cooperation
Power politics as zero-sum game	Win-win as preferred game
Politics as unending quest for advantage	Politics as pursuing a *telos* (*end purpose*)
Alliances conditional (oriented to threat)	Alliance networks vital to security
Ethos is amoral, if not immoral	Ethics are crucially important
Behaviour driven by interests, threats	Behaviour driven by common values, goals
Balance of power as the 'steady state'	Balance of responsibilities
Power embedded in nation-states	Power also embedded in 'global fabric'
Guarded, manipulative about information	Seeks information-sharing, inter-thinking

In essence, noopolitik is ultimately about whose story wins, not whose military seems stronger. This means that the conduct of noopolitik (and noopolitics

more generally) will depend on carefully crafting strategic narratives to suit varied contexts. The fact that narratives are crucial for manoeuvring in today's world, is widely accepted. As one expert has noted, 'Kinetics may win battles; narratives win wars' (Maan 2017). However, designing strategic narratives remains more an art than a science, and there is still plenty of room for new ideas about how to build expertise and wield influence.

For example, US efforts to promote democracy abroad – often through the use of force – have proceeded unsuccessfully, even defectively, for many years. The theologian Reinhold Niebuhr, still a favourite philosopher of many conservative (as well as some liberal) strategists, cautioned back in the 1950s that 'the greater danger [for US strategy] is that we will rely too much on military strength' (Niebuhr 1958:35) – a warning that has come all too true. Given the sorry record of militarism – most recently manifested in the American-led debacle in Afghanistan – the matter of how best to promote democracy may well become a key opportunity for noopolitik, as the answer(s) and strategies that noopolitik may develop, will likely prove quite different from what has been assumed and pursued under past grand strategies.

Here are some of the steps we have recommended to enable and energise a shift to noopolitik:

- Rethink 'soft power,' especially its dark sides: We should not have to list it. It should be cleared up by now, but it is not.
- Create international 'special media forces' that could be dispatched into crisis and conflict zones to help settle disputes through the discovery and swift dissemination of accurate narratives, and for purposes of rumour control and countering 'hate messaging.'
- Uphold 'guarded openness' as a strategic principle: This means remaining open (particularly among allies) in accordance with democratic values, while also creating mechanisms for guardedness (e.g., mutual defence treaties, robust cybersecurity norms, disease detection and control, and early-warning and tracing systems) to mitigate the risks inherent in being open.
- Take up the cause of protecting and managing the 'global commons' – those air, sea, land, space, and other parts of our planet that belong to no single state or jurisdiction – as a pivotal issue area for the future of noopolitik. Though valued by many civilian activists and military strategists, the global-commons concept has yet to gain public recognition, and it is presently under challenge from arch-traditionalists who prefer a return to nationalist/neo-mercantilist policies in the name of state sovereignty.
- Institute a governmental requirement for periodic reviews of the nation's 'information posture:' One's information posture toward allies and adversaries is now as crucial as one's military posture. The latter receives regular review. It is time to figure out how best to assess and enhance

the national information posture as well. (If a national information posture assessment were conducted at this time by, for example, the US government, it would surely clarify that Washington is in strategically worse shape – on matters ranging from cybersecurity to America's standing in world opinion – than its regular military and economic posture assessments seem to indicate.)

Such measures can open up transformational possibilities and opportunities for shifting from realpolitik to noopolitik as the basis of a new mode of statecraft attuned to the information age as part of the 4IR. They could help burnish the image of the US and its allies and friends in the world once again, lessen the bitterness and violence of conflicts, revitalise diplomacy, especially public diplomacy, and set the world on course toward sustainable peace and prosperity. Whereas realpolitik treats international relations as intractably conflictual, the starting point for noopolitik is faith in upholding our common humanity around the world, pursuing a belief that, in statecraft, ideas can matter more than armaments.

Even now, many shifts, risks, and conflicts that are commonly categorised as geopolitical in nature are, on closer examination, primarily noopolitical. For example, during the past decade or two the Arab Spring – affecting countries from the Maghreb to the Levant – the rise of the far right in Europe, Hindi-Muslim clashes in South Asia, protest movements in Venezuela, Sudan, Lebanon, Hong Kong, and Belarus, and most recently the fight for Ukraine, all have geopolitical implications, but they may be better understood as having an essentially noopolitical nature. Around the world, many cognitive wars – ideological, political, religious, and cultural wars – are underway, aimed at shaping people's minds and asserting control over this or that part of the emerging noosphere. Some analysts forecast the spread of information warfare into parts of Africa as well (Van Vuuren 2018). At the same time, people are also searching for new ways to get along together and cooperate in addressing such global challenges as pandemic control, climate change, and refugee resettlement. Here, too, policies and strategies guided by noopolitik rather than realpolitik will likely fare better for purposes of pursuing the common good.

New Frontiers for Teaching Statecraft and Grand Strategy

Colleges and universities have long offered courses, programmes, and degrees in international relations and other topics that concern statecraft. However, the few that focus specifically on grand strategy are quite recent. The first appeared only 10 years ago, at Yale University, with the creation of its Brady-Johnson Programme in Grand Strategy. Today not only Yale but also Duke University, the MIT (Massachusetts Institute of Technology), the IWP

(Institute of World Politics), and a few other schools offer their own courses, programmes, and degrees on grand strategy and statecraft.

For the most part, these courses revolve around classic readings in strategic thought and practice, from ancient Greece through modern times. They educate students, often through assigned readings in military and diplomatic history, about political, military, economic, social, and cultural forces that have affected international relations. The focus is mostly on state-led strategies and policies across the centuries. However, modern nonstate, citizen-activist, social-change movements may receive bits of attention too, as may the ways such movements benefit from the rise of new networked forms of organisation, enabled by the digital information revolution. Accordingly, class syllabi may range across writings by, *inter alia*, Thucydides, Niccolò Machiavelli, Carl von Clausewitz, H.J. Mackinder, Hans Morgenthau, and Henry Kissinger. The list can be made very long when it extends to including writings by the latest crops of theorists and practitioners.

A very broad range of both hard- and soft-power factors may thus be covered. However, for the most part, the hard-soft distinction is not a major theme, except when including what is deemed the single essential reading on this topic, which is Joseph Nye's seminal book, *Soft power: The means to success in world politics* (Nye 2004). As a result, these courses on grand strategy and statecraft generally cover the important roles that values, ideas, narratives, communications, culture, and other 'soft' ideational factors may play in international relations, in peacetime as well as in war (cf. Kennedy 1991). However, much greater attention is usually devoted to educating students about strategic concepts that have grown around the 'hard' material forms of power, e.g., geopolitics, realpolitik, realism, the use of economic coercion and military force, the balance of power, great-power competition, etc. Ever since Nye first fielded the concept of 'soft power' in the late 1990s, strategists have increasingly attended to the significance of soft-power factors, but not in systematic ways – no particular set of strategic concepts has yet arisen around it.

Suppose our forecast is correct about the noosphere and noopolitik. Then imagine how this may reshape curricula for graduate coursework on grand strategy. Current-day curricula seem quite staid, looking far more to the past than to what looms ahead. In recent decades, 'realists' have run into theoretical and practical challenges that their conventional approaches to strategy have proved insufficient for characterising or meeting much less mastering. Classes and readings for education about noopolitik will have to be very different from those used for realpolitik. Realpolitik requires knowing primarily about tangible military, economic, technological, and other geopolitical forces, and much less about intangible, ideological, social, and cultural forces. In contrast, noopolitik requires knowing primarily about

ideological, cultural, social, religious, and other noopolitical forces – and finding new ways of knowing about them.

In the US, strategic thinkers have long known, and urged that a grand strategy should attend to socio-cultural as well as political, military, technological, and other 'hard' contextual factors. However, in practice, strategists have repeatedly neglected analysing operational environments so comprehensively during the past few decades – they have neglected cultural and cognitive conditions to strategy's detriment, notably in Iraq and Afghanistan (cf. Hoffman 2020; Lynch 2020). Calls are finally emerging for rethinking grand strategy so that it attends equally and properly to 'the social dimension,' including its domestic import for grand strategy (cf. Arquilla & Roberts 2020). A future turn towards noopolitik will require this.

A comprehensive guide for how to become a knowledgeable practitioner of noopolitik remains a distant goal at this time – the concept is still too new, the writings too few. Nonetheless, we can list some topics that will surely require elevated if not entirely new kinds of attention as the noosphere and noopolitik take hold. We discuss them briefly below, in order to suggest their prospective future importance for teaching and learning in forward-looking courses and curricula about grand strategy. However, we expect that the topics we list here will eventually require far more pages of argument and elaboration before strategists, steeped in traditional approaches, become convinced that such a reorientation is needed.

Recognising the Significance of Social Evolution for Grand Strategy

We have never seen a writing that explicitly pairs social evolution and grand strategy for analysis. Yet, grand strategies often rest on judgements about social evolution – who is gaining strength, progressing the best, becoming a model for others to follow, etc. Modern examples include the containment theory in the 1950s, the modernisation theory in the 1960s, and democratic enlargement in the 1990s. In the 2000s, three ideas advanced during the previous decade that touched on social evolution theory: The 'end of history,' 'clash of civilizations,' and 'export of democracy' concepts influenced strategists engaged in the 'global war on terrorism,' which became notable for its presumptuous *naiveté* about imposing a democratic political evolution on tribalised, strife-torn societies in Afghanistan and Iraq. Attempts to reroute the currents of history and culture in these sad lands have foundered, at terrible human and material cost.

What a grand strategist thinks (or dismisses) about social evolution can make a decisive difference. Indeed, a case can be made that grand strategy would benefit immensely if it were grounded in a better theory about social evolution. This may seem a passing matter for realpolitik, but it may be a

requisite concern for noopolitik and noopolitics more generally – better ideas about social evolution will be needed in the coming age of the noosphere. Grand-strategic thinking that ignores social-evolutionary dynamics will not be worth much for long (especially for such purposes as fighting terrorism and promoting democracy in regions around the world). The fact that there is no agreed-upon theory of social evolution does not obviate this concern.

Exactly what a noopolitik-oriented curriculum should include is not clear today, but the aim would be to educate students to think more deliberately about social evolution and its implications for a grand strategy, without opting necessarily for a particular framework or theory. To this end, readings by Peter Turchin (2016) and David Wilson (2019) may be advisable, along with selected writings by David Ronfeldt (1996, 2009). Readings on specific topics, e.g., the evolution of government institutions, market systems, political democracy, and civil-society networks, may also deserve inclusion.

Realising the Significance of Social Cognition for a Grand Strategy

According to realpolitik, strategy is the art of relating ends, ways, and means – usually as defined in hard-power terms (cf. Marcella & Fought 2009). Strategy from a noopolitik perspective will be more about identifying, assessing, and affecting peoples' cognitions – a soft-power concept. Assuming that peoples' key cognitions are about space, time, and agency, then strategy may be regarded as an art of positioning for spatial, temporal, and 'agentic' (agency-oriented) advantages. For noopolitik, this may mean thinking and acting in global/planetary ways (spatially), while minding long-range future end-states (temporally) and creating new modes of agency to shape matters at all scales of strategy.

Why focus on people's space, time, and agency (or action, or efficacy) cognitions? The reason is that numerous psychological, sociological, anthropological, and other studies have shown that people's key cognitions are about space, time, and action (or agency). These cardinal cognitions – space, time, and action – take form in people's minds during childhood, and play key roles in shaping their beliefs and behaviours from then on. They are essential building blocks behind the development of consciousness and culture. No mind, culture, or society can function without its particular set of space, time, and action cognitions. Moreover, changes in people's space-time-action cognitions – their worldviews and mindsets – can lead to changes not only in an individual's beliefs and behaviours, but also in how a mass public thinks and acts collectively throughout an entire culture and society.

Thus, the better strategists can find ways to analyse people's space-time-agency perceptions, the better they can ascertain why people think and behave as they do, how societies and cultures evolve, and what makes

one historical era or phase different from another. Through such learning, strategists will be better positioned to assess the effects that different strategic options may have, including for such matters as climate control and pandemic relief.

Today, it would not be easy to design courses and curricula to educate students about how to do a triplex (i.e., space-time-agency) cognition analysis for purposes of grand strategy. Most experts have specialised in just one of the three key cognitions, in isolation from the others (even though the others always creep into their analyses). For the time being, courses and curricula would have to rely mainly on single-focus studies – say, Philip Zimbardo's writings about time orientations (Zimbardo & Boyd 2008), or Albert Bandura's about efficacy orientations (Bandura 2006). They should, however, still head steadfastly in the direction of a triplex cognition analysis until new readings emerge (as argued and forecast in writings by David Ronfeldt [2018]). All three cognitions are at stake, and being targeted, in various cognitive-warfare campaigns being waged in numerous societies around the world.

Finding Ways to Assess and Improve National Information Postures

The US has, over the past 75 years, provided an illuminating example of the governmental encounter with information strategy and policy, though it has yet to call for regularly assessing its information posture the way it has its military posture. Nevertheless, the American government does have a history of treating the nation's *de facto* information posture seriously – just not under that name. A modern landmark arose in 1946 with George Kennan's seminal 'containment' concept, which was meant to be applied more in the ideational than the military realm. Later, in 1953, President Dwight Eisenhower created USIA (the US Information Agency), and always included its director in cabinet-level meetings. As another landmark event, President Ronald Reagan ('the Great Communicator') called on his administration in March 1984, with his National Security Decision Directive 130, to develop a formal information strategy and posture review process. He then used it to help guide his summitry with Premier Mikhail Gorbachev and end the Cold War. Quite a set of accomplishments!

However, after the Cold War ended, President George H.W. Bush did not see fit to extend Reagan's initiative, preferring instead to proclaim an American-led 'new world order' based on preponderant military and economic strength, and in 1999, President Bill Clinton dis-established the USIA as an independent entity (it was folded into the State Department, where it remains up to today, much weakened). Thus, the US government began turning its back on developing a formal information posture at the very time when the digital information revolution and the 4IR were getting underway.

'Information' was already being reconceptualised as a new form of power, but mostly by foreign state and nonstate competitors who were intensifying their usage of new information operations against the US, its allies, and friends – without American or other friendly policymakers and strategists adequately realising much of any of this.

Today, new voices are calling on the US government to revitalise the USIA and rekindle the process that Reagan so wisely developed in 1984. These are good ideas, but far more than a limited institutional renaissance in one country will be needed in order to assure that policymakers begin to require national information-posture assessments as a regular matter. The US is still too enamoured of trying to impress other societies with its hard-power capabilities, e.g., as with its recent decision to share its nuclear submarine technology with Australia in an effort to counter rising Chinese influence in the Indo-Pacific region.

Posture assessments are normally about a nation's capabilities to apply all manner of power on behalf of its national interests – the case with US national military, economic, and cybersecurity assessments. These assessments are supposed to identify a nation's strengths and weaknesses, its priorities and possibilities, as well as vulnerabilities and risks, the better to enable a nation's leaders to craft strategies for meeting the ideational, organisational, operational, and other challenges that lie ahead.

To our knowledge, no one has ever tried to do a formal national information posture assessment. It could prove daunting as well as controversial to undertake. To begin, 'information power' and 'information posture' (not to mention 'information space') are far from settled concepts. However, if it could be broadly defined, spanning ideational as well as material aspects of 'information' (as we think they should be), then a posture assessment might be well advised to cover the following:

- Key aspects of a nation's image (the 'face' it presents to the world, its 'brand identity'), in particular the national values, goals, character, and the reputation it attempts to uphold and project, at home and abroad.
- The wealth (or lack) of information resources a nation has at its disposal and is developing (or failing to retain and develop) in schools, universities, research centres, libraries, and elsewhere in the 'infosphere,' including the nation's civil, public, and private sectors.
- The information policies and practices which a nation favours, for example freedom of information coupled with guarded openness in the American case.
- The status of infrastructures pertaining to stocks and flows of information, including the ways access is distributed or concentrated, management is centralised or decentralised, ownership and intellectual property are

proprietary or shareable, and whether the designs are suited to meeting national needs in case of emergency.
- The information-monitoring and -sharing networks that exist for coordination and cooperation across all levels of government – domestic and foreign – as well as with IGOs (inter-governmental organisations) and NGOs (non-governmental organisations) around the world on all manner of issues, and with business and civil-society actors at home.
- The range of media that are used for information gathering and broadcasting, as well as for uses that may range from message projection to early warning.

Such an assessment should identify strengths and weaknesses in a nation's information posture, its points of resilience, and vulnerability in case of an attack or other disaster. It should consider how well the posture serves to attract and work with friends and allies, as well as to deter or dissuade adversaries. It should set priorities and specify options for future improvements.

Today, the idea of formally assessing and improving a nation's information posture is so new and so lacking in background materials, that it would be difficult to specify, much less design educational courses and curricula. Yet, it is too significant a topic to set aside. So, for now, it may be best to approach the topic via exploratory workshops, rather than instructional classes. It may also be advisable for such workshops to try and design ways for all governments to eventually produce information-posture assessments, not just one's own government (or other entity).

Additional Topics for Education in Noopolitik

The preceding three topics are easy to suggest, for they derive from our recent work. Yet, they are just a beginning. Other topics could easily be added to this list. For instance, the significance of strategic narratives – in light of the centrality of 'whose story wins' to noopolitik, future strategists should receive training in the construction and application of forward-looking strategic narratives. Another topic might be the growing significance of having (and building far more) networks of sensory technologies and sensory organisations around the world to monitor, share, and act on information about global health, education, environmental, and other critical matters that cross jurisdictional boundaries (imagine the benefits, had such a network been in place as Covid was emerging). At first, this may sound like a mostly technical matter, but no, for this topic will prove to be mostly about designing and building vast organisational and informational networks that involve all sorts of state and nonstate actors, large and small, near and far. Thus, as the noosphere and noopolitik grow in tandem, organisational races to build networks may well prove more important than the technological races to

build ever newer products and weapons, catalysed by the digital information revolution and the 4IR in which it is embedded.

Coda

New courses and curricula for such matters would make for a very different, far more future-oriented approach to educating students about statecraft and grand strategy in the age of the 4IR. To our knowledge, such matters are not being addressed much, either singularly or collectively, in today's institutions of higher learning. However, in other areas of inquiry, from the scientific to the economic and beyond, innovative curricular design initiatives have begun, many focusing on the importance of 'university-industry collaboration' (for a good overview, cf. Perkmann & Walsh 2007; Salleh & Omar 2013, for an excellent overview of the impact of this approach in a developing country like Malaysia). The particular value of university-industry collaboration is that there is a cross-fertilisation of insights into the implications of the 4IR between the academy and industry that quickens the development process. Such a collaboration, attuned to university-industry-government collaboration and focused on grand strategy, might well have profoundly beneficial effects.

It is also interesting to note that the aforementioned literature on these collaborations keys on the importance of employing inquiry-based, problem-solving 'design approaches' to curricular development as having more impact than the traditional frameworks, based on either formal analytic or socio-historical paradigms. Given that the 4IR is still in its early stages, particularly in areas like AI (artificial intelligence), additive manufacturing, and gene editing, etc., there is probably good reason to focus more on design approaches than more traditional quantitative, algorithm-driven, or historical/sociological methods when building new curricula. Design, as noted above, seems to be working quite well across a range of fields. It may be ideally suited to improve the theory and practice of grand strategy too.

Admittedly, the ideas and observations we have offered here are preliminary – for example, further discussion would surely lead to more refined ways to conduct a national information posture assessment. There is also much more to investigate about curricular design. Yet, if our forecasts about the rise of the noosphere and noopolitik are correct, then it is already well past time we all begin exploring and adapting to these new frontiers. Time grows short, as the effects of climate change worsen for all, and even so-called 'limited conflicts' wreak horrible human havoc *in situ* and inflict profound, globe-spanning economic disruptions. *Realpolitik* is proving ever less relevant as a guide to effective grand strategy in the age of the 4IR. *Noopolitik* is ready to step in.

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Chapter 7

Developing Critical Workplace Skills through Education in Africa: The Case of Industry 4.0 Revolution

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Introduction

This chapter aims to explore and discuss substantial changes in critical skills development and education systems for I4R (Industry 4.0 Revolution) in Africa, and to equate different educational approaches evolving in connection with education in Africa. Methodologically, the chapter follows a qualitative approach to synthesise literature to answer questions like, 'How can African nations respond to I4R, or will they remain behind as it was the case with the first three industrial revolutions?' 'Are Africa's education systems ready to produce human capital for I4R?' Finally, 'How can organisations leverage the power of I4R to tackle today's challenges such as the Covid-19 pandemic, internationalisation, and globalisation?' The chapter offers an evaluative viewpoint on the diverse innovative responses evolving in Africa's education systems and in curriculum development for sustainable development to address challenges of I4R. The chapter provides twofold implications on how education in Africa may act both as a source of competitive advantage for African nations and an enhancement of their commitment to industrialisation. This chapter further fills a literature gap regarding how education policymakers can take advantage of their youthful population and opportunities to create an innovative society for I4R and beyond.

In the discussions below, this chapter will cover the following themes: The historical development of IRs (industrial revolutions) in the context of Africa *vis-à-vis* the world; education in Africa; post-I3R (Industry 3.0 Revolution); careers and skills shift in the context of I4R; concept and definitions of I4R; demand driven skill sets for I4R; the role of education in developing critical skills in Africa for I4R; and the future of Africa in I4R. The chapter also highlights challenges such as Covid-19 and how educational organisations can harness the power of I4R for human capital capacity building to tackle current challenges facing the continent.

Historical Development of Industry 4.0 Revolution

Historically, the IR started in the West around the 16th century when there was a demand for industrially manufactured goods. Following the first three IRs, I4R is characterised by digital transformation, the IoT (internet of things), DA (data analytics), AI (artificial intelligence), CPS (cyber-physical space), IoS (internet of services), AM (additive manufacturing), and CC (cloud computing) respectively. I4R is to become a reality in the next decade (cf. Fig. 1). The political debate about the term 'I4R' focuses on both the important and abstract objectives. For its promoters, I4R is not only about improving Germany's international competitiveness, but is also regarded as a tool for tackling the most pressing global challenges such as the consumption of renewable and non-renewable resources, as well as specific national challenges like the labour supply that is changing due to demographic shifts. I4R is focused on smart production, consisting of smart products, procedures, and processes. A key element of I4R is therefore the smart factory/manufacturing (cf. Fig. 1). In addition to the foregoing challenges, I4R can help to tackle emerging issues such as the Covid-19 pandemic, internationalisation, and globalisation of both skills and knowledge through 5G (fifth generation), AI, and BDA (big data analytics), to mention a few.

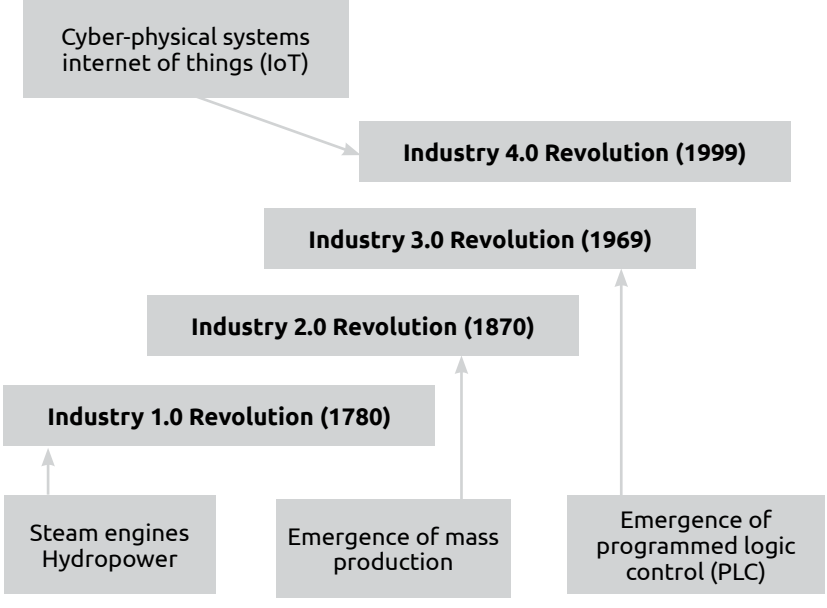


Figure 1: Chronology of Industrial 4.0 Revolution. Source: Personal archive

The first three IRs led to the change of paradigms in the domain of manufacturing: Mechanisation through water and steam power, mass

production in assembly lines, and automation, using IT (information technology). I1R (Industry 1 Revolution) began around the 1780s with the introduction of water and steam power which helped in mechanical production and improved the agriculture sector greatly (Liao, Deschamps, Loures, & Ramos 2017).

Industry 2.0 Revolution

I2R (Industry 2.0 Revolution) is defined as the period in which mass production was introduced as the primary means to production in general. The mass production of steel helped to introduce railways to the industrial system, which consequently contributed to mass production at large (Liao *et al*. 2017).

Industry 3.0 Revolution

During the 20th century, I3R (Industry 3.0 Revolution) emerged with the advent of the digital revolution which is more familiar with the digital environment than I1R and I2R, as most people living today are familiar with industries, and leaning on digital technologies in production. Perhaps I3R was and still is a direct result of the huge development in computers and ICT (information and communication technology) industries for many countries (Liao *et al*. 2017). In Germany, the term 'Industrie 4.0' was brought about in 2011 to strengthen the country's industry (Ghobakhloo 2018; Veile, Kiel, Müller, & Voigt 2019). The German government funded the initiative as the backbone of its strategy to digitise the industry. The German's philosophy behind I4R is that 'manufacturing systems are vertically networked with business processes within factories and enterprises. Industry 4.0 Revolution has brought change to many professions' (Agolla 2018; Ardichvili, Zavyalova, & Minina 2012).

People have always been obligated to learn new everyday tasks, but now they are also compelled to use hi-tech gadgets, which are fast becoming the most important factor in their working lives. For example, the emergence of the pandemic in 2019 caught the world by surprise, causing disruptions such as the shutdown of the world's economies and operations. Big parts of the world immediately adopted social distancing and working remotely. This created challenges to both workers and academics (including students), as the new normal demanded immediate applications of the IoT, such as BDA, and VR (virtual reality) to continue with their businesses. In hurried manner, both workers and academics were required to adjust, hence, to start using the features of I4R. The rate at which this new normal was being implemented, did not match the skills and knowledge available to enable the smooth implementation of these features, given that most workers and academics were technologically incapable to adopt these features. However, the one notable thing is the increased H2M (human-to-machine) or H2T (human-

to-technology) interactions which have never been witnessed before the emergence of the pandemic. I4R is being presented as an overall change by the digitalisation and automation of every part of the organisation, as well as the manufacturing process (Schwab 2016). Big international companies that use concepts of continuous improvement and have high standards for research and development will accept the concept of I4R and make themselves even more competitive in the market.

Concept and Definitions of Industry 4.0 Revolution

The I4R concept must encompass not only value creation *per se*, but also work organisation, business models, and downstream services. It does this by using IT to link up production, marketing, and logistics and thereby capture all resources, production facilities, and warehousing systems (Matthias, Fouweather, Gregory, & Vernon 2015; Chuang & Graham 2018). The re-organisation thus extends from the energy supply and smart power grids to advanced mobility concepts which are smart mobility and smart logistics. On the technical side, the concept is based on integrating cyber-physical systems into production and logistics, and the rigorous end-to-end implementation of the IoT and services in industrial processes (Mrugalska & Wyrwicka 2017). In this smart environment, the concept of the IoT and services that were already devised a decade ago, will now become a reality. This process involves developing people and capital mobility, changing modes of production, consumption, learning, working and leisure, and increasing worldwide competition (Migliore 2015; Murawski & Bick 2017). The three major components contributing to individual or small team creativity are expertise, creative thinking skills, and intrinsic motivation (Collet, Hine, & Du Plessis 2015; Ibrahim, Boerhannoeddin, & Bakare 2017; Karakas & Manisaligil 2012). While there is evidence of formal education systems in the Western world during I1R, there is no mention that such formal education did happen on the African continent. However, this does not mean that the African continent never had any form of education. A lack of documentation about events and activities taking place in the society, contributed to this missing link.

Definitions of Industry 4.0 Revolution

Kagermann, Wahlster, and Helbig (2013) define I4R as 'utilising the power of communications technology and innovative inventions to boost the development of the manufacturing industry.' I4R encourages the manufacturing efficiency by collecting data smartly, making correct decisions and executing decisions without any doubts. For example, BDA is useful in executing business decision-making, particularly in the prediction and tracking of both students' intentions to drop out and their performances. This simply means that an over-relying on human beings for data collection,

storage, and analysis is minimised if not eliminated, hence improving the pace at which the decisions are fed into the operations (Becker, Burghart, Nazemi, Ndjiki-Nya, Riegel, Schäfer, & Wissmann 2014). By using the most advanced technologies, the procedures of collecting and interpreting data will be easier. The interoperable operating ability acts as a 'connecting bridge' to provide a reliable manufacturing environment in I4R (Heng 2014). This overall consciousness gives I4R the most important aspect of AI functions (Qin, Liu, & Grosvenor 2016). I4R is surrounded by a huge network of advanced technologies across the value-chain. Service, automation, AI, robotics, IoT, and additive manufacturing are bringing in a brand-new era of manufacturing processes. The boundaries between the real world and virtual reality are getting blurrier and causing a phenomenon known as CPPS (cyber-physical production system) (Schumacher, Erol, & Sihn 2016).

I4R makes full use of emerging technologies and the rapid development of machines and tools to cope with global challenges to improve industry levels. The main concept of I4R is to utilise advanced IT to deploy IoT services (Becker *et al*. 2014). Production can run faster and more smoothly with minimum downtime by integrating engineering knowledge. Therefore, the product, which is to be built, will be of better quality, while production systems are more efficient, easier to maintain, and more cost effective. I4R is differentiated by a few characteristics of new technologies, for example physical, digital, and biological worlds (Mohamad, Sukarma, Mohamad, Salleh, Rahman, Rahman, & Sulaiman 2018). The improvement in technologies is bringing significant effects on the development plans of industries, economies, and governments. Schwab points out that I4R is one of the most important concepts in the development of the global industry and the world economy (Schwab 2016).

The modern and more sophisticated machines and tools with advanced software and networked sensors can be used to plan, predict, adjust, and control the societal outcome and business models to create another phase of value-chain organisation and it can be managed throughout the whole cycle of a product. Thus, I4R is an advantage to stay competitive in any industry. To create a more dynamic flow of production, the optimisation of the value-chain must be autonomously controlled (Mrugalska & Wyrwicka 2017). For example, BDA improves the productivity of education, using its technology all over the levels of the education system, at teaching, retention, administration, and reporting (Bamiah, Brohi, & Rad 2018). It facilitates the outlook and effectiveness of education by enabling the extraction of insights from learning experiences, tracking learners' learning processes and progress, besides ensuring their retention (Bamiah *et al*. 2018). However, despite these benefits, there are still some challenges that hinder its full implementation, particularly in Africa. The complexity of architecting big data, especially with

legacy educational systems and the shortage of experts, besides the security, privacy, and ethics issues, should be considered when implementing BDA in education (Bamiah *et al.* 2018).

Features of Industry 4.0 Revolution

I4R has created a new economy, called the *Gig economy model*, which is also known as *shared economy*, being hinged on digital platforms and AI. This has created chaos in the traditional understanding of employment relationships and career sustainability in manufacturing. Typical features/characteristics of I4R and its application workplace are as follows:

- BDA: This is the utilisation of digital technology to conduct analysis. It can be used in student performance tracking, extracurricular interactions, and results of social behaviour by creating a profile that can be mapped with student profiles from the institution's network, to suggest the most relevant major faculty courses (Muhammad, Tasmin, & Aziati 2020). In addition, improved decision-making, and resource management, as well as the success rate of students can be increased by identifying risks at an earlier stage (Tulasi 2013). Similarly in healthcare, BDA can be applied to predict viral diseases such as Covid-19 before spreading, based on a live analysis. This can be identified by analysing the social logs of the patients suffering from a disease in a particular geo-location. It assists the healthcare professionals to advise the victims by taking necessary preventive measures (Archenaa & Anita 2015).
- SIMULATION: Simulations are done by using RTD (real-time data) to represent the real world in a simulation model, which includes humans, products, and machines.
- IoS: IoS acts as 'service vendor' to provide services through the internet according to the types of digitalisation services. In short, IoS is concerned with and makes use of the internet for new ways of value creation through the materialisation of a PaaS (product-as-a-service) business model (Chawlaa, Angrab, Suric, & Kalrac 2020). The process directly links the producers with the customers, hence resulting in reduced time for the services to reach the customers. Using the faster internet connectivity based on a superhighway such as 5G (fifth-generation) communication networks, customers are assured of faster service deliveries (Chawlaa *et al.* 2020). The premise of IoS is to create seamless direct links between the manufacturers of consumer products with the consumers, and to strengthen their competitive position by offering supplementary services and cultivating additional sources of revenue, based on a technological infrastructure which is provided by IoS (Becker *et al.* 2014; Ghobakhloo 2018).

- AR (AUGMENTED REALITY): This technology can bring huge support for maintenance works in business due to reduced time needed for maintenance works and a reduction of potential errors in maintenance works (Becker *et al.* 2014). It can predict with high accuracy and allows the frequency of maintenance to be kept at low numbers by utilising predictive maintenance to prevent any unplanned reactive maintenance.
- CPS: Each production system of CPS has sensors installed in all the physical aspects to connect the physical things with virtual models (Tay, Lee, Hamid, & Ahmad 2018).
- AM: I4R is stimulating the utilisation of advanced data technologies and smart production systems. Hence, AM is one of the crucial tools to embrace I4R.
- IoT: It can provide an advanced connectivity of systems, services, and physical objects, enabling object-to-object communication and data sharing. IoT is a network of physical objects, machines, people, and other devices that enables connectivity and communications to exchange data for intelligent applications and services (Schallock, Rybski, Jochem, & Kohl 2018). These devices consist of smartphones, tablets, consumer electronics, vehicles, wearables, and sensors that are capable of IoT communication (West 2016). The world is already referring to 5G networks that are capable of faster communication. IoT is characterised by devices such as 5G communication networks that can enable one to download an interactive 3D (three dimensional) video in a few seconds, a smart home which anticipates your needs, while autonomous vehicles take you safely to your destination (West 2016). All these gadgets are already being tried and tested, and it is envisaged that countries such as Sweden, Germany, Finland, Japan, China, the US, and many others will have driverless cars by the year 2030. This world of 5G broadband technology promises speeds of more than 100 megabits per second, more data bandwidth, and fewer delays due to built-in computing intelligence that handles data very efficiently (West 2016). This will result in bringing together improved connectivity, cloud-based storage, and an array of connected devices and services (West 2016). Advanced digital networks will bring together a system that connects billions of devices and sensors, enabling advances in health care, education, resource management, transportation, agriculture, and many other areas (West 2016).
- CC: This is a (new) system logic that provides a huge space of storage for the users. In CC, the storage of information is limitless, as this provides a huge space for storing vast and large data in a retrievable state for easier use by the end users, hence, eliminating an over-reliance on physical storages that was synonymous with the past three IR phases (Wilkesmann & Wilkesmann 2018). Such developments eliminate risks associated with

storages namely missing documents, hard copy files, costs associated with storage spaces, and many others. It also eliminates all sorts of physical spaces that have been the characteristics of the three previous IRs (Becker *et al*. 2014; Chawlaa *et al*. 2020; Mrugalska & Wyrwicka 2017). In terms of workplace skills and competencies which will be needed in I4R, there seems to be a unanimous understanding that some shifts demand unique sets of skills that may be differentiated with current ones (Raul, Katz, Koutroumpis, & Callorda 2013). Such skills are not similar to someone with skills, competencies, and knowledge of record keeping, but rather someone with technical skills in CC.

- AUTONOMOUS ROBOTS: Today's robots are more flexible and advanced in their operations and functions, in addition to being easier to operate in multitudes of fields. These robots can interact with each other through collaborative networks, while at the same time being able to have a real-time interface with humans under the guidance of handlers (Raul *et al*. 2013). The implication is that employees working in line assemblies and manufacturing need to be reskilled and retooled to remain relevant in the job market, or completely become jobless as most of the work will be carried out by the robots (Teng, Ma, Pahlevansharif, & Turner 2019).

The smart factory controls the fast-growing complexity while also boosting production efficiency. In the smart factory, there is direct communication between human, machine, and resources (Iyer 2018). Smart products know their manufacturing process and future application (Rowe 2019). With this knowledge it actively supports the production process and the documentation ('When was I made?' 'Which parameters am I to be given?' and 'Where am I supposed to be delivered?'). With its interfaces to smart mobility, smart logistics, and smart grids, the smart factory is an important element of future smart infrastructures. Conventional value chains will thereby be refined, and totally new business models will become established (Agostini & Filippini 2019). With all these in mind, and the obvious fact that workplace characteristics have changed – hence the skills sets too – human beings will have to interact with robots and communicate to produce goods and services that were formally traditionally reliant on mechanically production processes (Rowe 2019).

The main features of I4R lead us to pose one question: 'What should the skills and knowledge be like in I4R?' In the following section, we discuss some of the skills and knowledge found to be very relevant.

Critical Skills for Industry 4.0 Revolution

Globally, the world is going through a series of fast transitions due to the digitalisation automation of economies propelled by I4R. Many of the

challenges that are being addressed because of I4R skills, are Covid-19 associated issues that shifted learning and working to remote learning and working. Globalisation has created a window of opportunity and challenges the world on how education is worldwide being offered to students. Due to globalisation, any education system must offer leaners knowledge and skills that make them fit well into a diverse work environment other than that of their original country of domicile. For example, Japanese education providers, with their headquartered in Tokyo, using the power of I4R, specifically VR, can now have classes going on simultaneously in over five different continents with multiple students having connections to the lecturer in Japan. This creates an interactive platform where students from different continents and their lecturers communicate effectively just like in physical face-to-face lectures. Now educational institutions are using I4R features such as VR in the form of virtual classes to reach out to millions of students across the globe. This has reduced the costs and expenses that were formerly associated with travelling to the place where such learning takes place, as education can be provided seamlessly to students anywhere and anytime. All these features of I4R have become a reality with the onset of Covid-19.

For example, due to the pandemic, many educational institutions around the world were forced to adopt key features of I4R such as VR and BDA to continue providing classes to their students. The pandemic converted the centuries-old face-to-face teaching paradigm into a technology-driven one (Rizvi & Nabi 2021). Educational institutions quickly adopted some form of ODL (open and distance learning) practices, which would not be possible without the application of I4R technologies (Hall, Connolly, Grádaigh, Burden, Kearney, Schuck, Bottema, Cazemier, Hustinx, Evens, Koenraad, Makridou, & Kosmas 2020). The advancement of, and innovations in technology have affected different fields of our daily life, including methods adopted for education and trainings (Kant, Prasad, & Anjali 2021). Technology has transformed how ODL could currently be offered to students. Many institutions offering ODL have embraced most of the I4R features such as VR and DA to reach out to students. Features that have found usage in ODL are digital initiatives, the production of SLMs (e-materials/e-speech learning models), the design of MOOCs (massive open online courses), OERs (open educational resources), LMSs (learning management systems), and the evaluation of learning materials which have been included in the training curricula. I4R provides arrays of opportunities to not only ODL institutions, but even conventional ones, as it quickly adopted the digitalisation of education due to Covid-19, to better serve the educational needs of more varied students. I4R can be utilised to optimally harness the basket of technological advancements which opens a plethora of more recent possibilities (Kant *et al.* 2021).

ODL has transformed itself from correspondence to *virtual* learning, where students can access education through various platforms. However, the quality of the learning heavily depends on digital access levels and accessibility (Rizvi & Nabi 2021). I4R has not only transformed the way ODL is being offered to students, but the conventional systems due to the pandemic have equally changed. It is currently estimated that 60 percent of the world's student population is online. In most countries today, specifically the developed world, virtual classes on personal tablets have become standard, while many developing countries still rely on lessons and assignments sent via WhatsApp or e-mail. While this could be afforded by many students both in the developed and developing world, there are still many other students who are left out due to several factors such as internet connectivity and finances, among others.

These transitions have not only challenged the way in which humans interact with their environment, but it has also created what we may call, a *Gig economy* (Rowe, Moss, Moore, & Perrin 2017). The Gig economy, simply put, refers to a 'shared economy,' which is characterised by digital platforms, as well as AI, BDA, CPS, and DA, which are typical of the I4R environment (Chawlaa *et al*. 2017). In the Gig economy, the world witnesses more flexibilities and opportunities for workers to take control of their work-life balance. Here we refer to Covid-19 that has forced employers to provide their workers with an alternative of working from the comfort of their homes (Becker *et al*. 2014). This has resulted in a reduction of costs associated with travelling to and from workplaces, as workers could take care of their homes without necessarily engaging the services of home caretakers. While this could be viewed as positive, a side effect that could have a profound impact, is the social isolation of the workers.

Historically, the pandemic started around November 2019 and became global during February 2020. Whereas it was first identified in Wuhan (China), its origin is still unknown. The world education systems have been impacted by this pandemic, imposing formidable challenges, and creating a discontinuity of operations. To effectively respond to this impact, many ordinary workplaces and education systems were hurriedly transformed to digitalised learning systems to mitigate the effects of the pandemic. For example, modern machines could be used not only in educational institutions, but also in the medicine field to plan, predict, and control the effects of the pandemic. Another example of I4R is the simulation using RTD to represent the real world.

The development of computerised learning modules enables the assessment of students in systematic, real-time ways. Data mining and data analytic software can provide immediate feedback to students and educators about academic performance (West 2012). In health, with reference to

Covid-19, I4R features such as BDA are vital in discovering valuable decisions by understanding the data patterns and the relation between them with the assistance of machine learning algorithms (Archenaa & Anita 2015). That approach can analyse underlying patterns to predict student outcomes such as dropping out, needing extra help, or being capable of more demanding assignments. It can also identify pedagogic approaches that seem to be most effective with students (West 2012). For example, an online high school curriculum known as *Connected Chemistry* helps students to learn key concepts in molecular theory and gasses. Chemistry is made up of many elements which interact in complex ways to form chemical systems (West 2012). The programme helps learners to understand how sub-microscopic particles relate to macroscopic phenomena. The employment of this software allows educators to mine learning patterns to see how students master chemistry, statistics, experimental designs, and key mathematical principles. They do this through embedded assessment tools as well as pre- and post-test evaluations (West 2012). The results indicate that students go through steps in developing mathematical models of complex chemical processes. In relating the volume and pressure of gases, educators found that half of the students were not able to use maths to summarise key relations and measure how different volume levels affected gas pressure (West 2012).

In summary, we learn that I4R did not only provide us with characteristics that are applicable to the manufacturing sector, but also with the new workplace environment features, which are demanding in terms of digital knowledge and skills, creativity, creative thinking, analytical thinking, and numerical competencies as opposed to the previous three revolutions (Ajagunna, Pinnock, Johnson, & Teare 2018). For example, as discussed above, Covid-19 has disrupted many aspects of human life, such as employment prospects, economic prosperity, education, business, social life in the form of social distancing, as well as personal and professional relationships (Salam & Bajaba 2021). World connectivity was disrupted as different countries imposed travel bans and shut their boarders.

Several skills and knowledge sets have been added to the traditional skills domain to address the skills gap between I4R and the past three IRs (Moon 2018). In Table 1 below, such skills and knowledge have been divided into two domains, namely technical and non-technical (soft) skills. Specific research studies have summarised the skills needed by today's workers to fit well into I4R (cf. Maisiri, Darwish, & Van Dyk 2019).

Table 1: Industry 4.0 Revolution Skills

Skills category	Sub-skills set	Skills set
Technical skills	Technological skills	Designing skills that incorporate virtualising, simulating, interoperability, modularising, and decentralising capabilities. Fault and error skills. Application and use of technological skills. Process digitalisation and understanding. Ability to work with the IoT, autonomous robots, 3D printing, and other advanced technologies. Interaction with modern interfaces.
	Programming skills	Computational skills. Simulation skills. Coding. Computer and software programming skills. Software development.
	Digital skills	DA/data processing. IT/data/cyber security. CC skills. IT knowledge and abilities. AI skills. Digital content creation skills.
Non-technical skills	Thinking skills	Creativity, innovation, practical ingenuity. Critical and logical thinking. Flexibility. Complex problem solving and troubleshooting. Analytical thinking skills. Technical and literate communication. Collaboration (including machine-human skills). Interdisciplinary skills.
	Soft skills	Teamwork. Perspective-taking. Professional ethics. Understanding of diversity. Self-awareness, self-organisation. Interpersonal skills. Intercultural skills.

Skills category	Sub-skills set	Skills set
	Personal skills	Social responsibility and accountability. Lifelong learning skills. Leadership skills/people management. Emotional intelligence. Negotiation skills. Entrepreneurship. Adaptability.

Source: Reproduced with permission from Maisiri *et al.* (2019:99).

Education in Africa for Industry 4.0 Revolution

In the foregoing sections, we will discuss the concept, the main features/characteristics of I4R, and how it has changed the world of work in terms of skills, competencies, and knowledge that employers will require for job applicants to have (Rowe 2019; Teng *et al.* 2019). During I1R, Africa as a continent was a land mass without independent states as it is today. It was therefore one large mass of land occupied by people who were using crude forms of production as means to achieve their socio-economic goals (Chhetri, Gekara, Manzoni, & Montague 2018; Cotsomitis 2018). This trend continued until late I2R. During this period, Africa provided raw materials to the world, propelling the three stages of the Western industrial revolutions and civilisation. From I3R onward, African countries were gaining their independence from their colonial masters, hence most of the education systems were either not in place or effective to propel the continent to industrialisation (Maisiri *et al.* 2019).

Africa is rich in natural resources. However, this continent does not seem to be intellectually rich enough to enable it to utilise its vast resources for both domestic and international prosperity. In Figure 1, the study has demonstrated the chronological order of the evolution of the IRs, with each stage indicating various technological discoveries and inventions (Mubarak, Suomi, & Kantola 2020). Of interest is that very little of these developments are attributable to the continent. However, with I4R, Africa is expected to claim its rightful place by becoming a force in terms of technological advancement in all spheres of its activities. Africa is well endowed with youthful people as well as natural resources, things which are very critical for the success of I4R. in 2021, the Africa population stood at approximately 1.4 billion people of which the average/median age was 19.7, based on the UN (United Nations) estimates (ECA 2021). With these numbers, Africa can produce and consume what its manufactures want to, without necessarily

seeking external markets. However, this would require huge investments in real-time efficient infrastructural networks within the continent to allow for the smooth flow of services, goods, and people.

Education has been and will remain the main determinant of the nations' competitiveness. As nations usher in I4R, the first two questions that come to mind are, 'To what extent is the education curriculum provider ready to embrace both gains and challenges brought about by I4R?' and, 'To what extent do African countries leverage their education system to harness their intellectual capital for I4R?' I4R is changing the way the society thinks about and transacts businesses. Historically, the term 'ESD' (education for sustainable development) was first coined at the Johannesburg Summit in South Africa in September 2002. Later that same year, the UN General Assembly passed a resolution proclaiming the period of 2005 to 2014 to be the UN decade of sustainable development. With the global challenge of literacy eventually and effectively being addressed, it is important that literacy is incorporated into the global and national Covid-19 pandemic responses and recovery plans for students of all ages (Rizvi & Nabi 2021). There is a need to ensure a learning continuity, increased access, and strengthened national lifelong learning programmes and capacities.

The conceived ESD had five tenets:

- Education that allows students to acquire the skills, capacities, values, and knowledge required to ensure sustainable development;
- education that is dispensed at all levels and in all social contexts (family, school, workplace, and community);
- education that fosters responsible citizens and promotes democracy by allowing individuals and communities to enjoy their rights and fulfil their responsibilities;
- education based on the principles of lifelong learning; and
- education that fosters an individual's balanced development.

For these tenets to be achieved in a holistic way, the integration of various components of ESD into curricula at all levels of education and in all sectors of the society is of paramount importance. It is worth noting that when the advocates of ESD convened a meeting in Johannesburg, they were clear in their minds that ESD was to solve the problems that would confront the environment directly. As a result of this, most countries adopted environment issues in their educational curricular presentations at HE (higher education) levels.

Curriculum Innovation in Africa

The changes brought about by I4R have necessitated widespread changes in the way education and training will be conducted. As we have referred to the features/characteristics of I4R, it is evident that skills and knowledge required for jobs in the workplaces have shifted. Educational curricula are meant to shape human beings socially, economically, morally, politically, and finally to prepare them for work, a trend that is based on the notion that employers will have to impart much needed competencies on the jobs (Tait 2018). Therefore, a good curriculum is one that addresses the above tenets that would be likely to bring benefits to the society that it is meant to serve. On the one hand, innovation requires a society that is open to new things and ready to adopt changes, which foster social and economic development (Pulkka 2019).

Whereas innovation takes place almost every day in the society, it took almost a decade for education to reflect such changes in the society in the similar pace and fashion in its curricula. This has caused a gap between the curricula and the workplace requirements in terms of skills, competencies, and knowledge as well as HE systems all over the world, which are synonymous with the production of young graduates who are not capable to cope with the demands of the innovation taking place in the society (Morselli 2018; Naim & Lenka 2018), therefore creating a mismatch between job seekers and employment opportunities available in the workplace. This mismatch, if not bridged, is likely to cause structural unemployment, as most of the graduates from educational institutions may not fit well in I4R work environments (Chuang & Graham 2018). The shift in the workplaces in terms of knowledge, skills, and competencies due to I4R, will now require all educational providers to redesign their curricula, to move away from theories and be more industry-based to prepare graduates for I4R job requirements (Maisiri *et al*. 2019; Teng *et al*. 2019). This changing demands in the workplace have shifted towards a broader remit, which focuses on the attitudes and behaviours of employees, including their ability to communicate and solve problems as well as evidencing resilience at work, collectively contributing towards work readiness (Rowe 2019). HE is conceptualised, as those education providers offer vocational education or tertiary education and post-secondary certificates.

Curricula are critical in developing capable citizens, ready to undertake any assignments that require their cognitive abilities. The formal education world has evolved in line with the IRs, but not at the same pace at which technological development has evolved. To match the pace of industrial development and economic changes, curricula must be revised in similar fashion. The question here is whether IHEs (institutions of higher education) are truly able to adapt quickly enough to an increasingly uncertain and volatile market, through collaboration with employers to create future-proofed,

innovative curricula with delivery models that meet learner and business needs (BCES 2014; Nguyen 2018; Rowe 2019). With the rate at which technological development and advancement take place, it would be profitable for IHEs to have a strong link with the employers in order to know how to respond to the workplace needs. Failing to have such links would just result in futility in terms of preparing graduates who are ready for jobs which are available in the markets (Witte 2014; Wolhuter, Van der Walt, & Steyn 2016). Therefore, educators should consider opening up IHEs for more interactions with industry, and more importantly to give them more scope in curriculum design and development to respond to job markets in terms of skills and knowledge.

South Africa

South Africa, just like any other developing economy has not been left behind in its quest for skills development in preparing for I4R. The country has already prioritised its human capital development needs to bridge the skills gap between education and businesses.

To transform the education practices that existed within the country up to 1994, the South African Ministry of Education decided in 1996 to adopt a new education structure, the NQF (National Qualifications Framework) and philosophy/approach (outcomes-based education). Changes in education structures are linked to the rethinking and re-examination of existing structures, philosophies, curricula, and its related components. Today, the South African education system has engaged with the 21st-century skills through the development of CAPS (Curriculum and Assessment Policy Statement), which is a single, comprehensive policy document that provides guidance for learning and teaching in South African schools. In the curricula, the embedded skills and values associated with I4R are found. The curriculum goals are to produce students that can identify and solve problems, making decisions by using critical and creative thinking, working effectively with others, critically evaluating information, communicating effectively, and showing a responsibility towards the environment and others. Apart from these skills, we find a wider government prioritisation of the promotion of inclusion, diversity, equity, and life in the I4R, which are driven by the country's historical past. The key salient features of Souths Africa's education curricula are:

- identify problems;
- solve problems and make decisions;
- critical and creative thinking;
- team players, groups, organisations, and communities;
- organise and manage effectively;
- collect, analyse, organise, and critically evaluate information;

- communicate effectively, using visual, symbolic, and/or language skills in various modes;
- use science and technology effectively and critically, showing a responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Moreover, in the Report of a ministerial task team on the implications of I4R for the post-school education and training system (DHET 2020:35-41), the South African government identified some of the key areas at the centre of the new vision for the PSET (post-school education and training) system to be the focus on ensuring that the programmes, courses, and other learning opportunities are aligned with the needs of I4R. They envision a PSET system that provides:

1. A strong core of education and training programmes that align with the changing needs of both the South African society and the world of work in the context of the I4R. Instead of generic and superficial curricula, PSET programmes are envisioned to provide access to specialised skills and content, grounded in disciplinary bodies of knowledge, and providing space for growing inter-disciplinary engagement. Critically, the mechanisms for reviewing and updating PSET programmes and curricula will be revised and streamlined to enable curriculum development to keep pace with the production of new knowledge, enabled by I4R requirements.
2. Access to high-quality educational opportunities that meet a burgeoning and immediate demand for 'digital skills' in the labour market created by the 4IR and a parallel need for a new wave of South African innovators and entrepreneurs who, whether from within government, in the private sector, or broader civil society, will help to drive and shape the I4R to the social and economic benefit of all its citizens.
3. Massive increases in short-course skilling opportunities for unemployed and underemployed South Africans in parallel with wider government and private-sector efforts to rapidly grow new employment opportunities for those people. In scaling up access to these skilling opportunities, the PSET system – and particularly the CET (community education and training) and TVET (technical vocational education and training) college sectors – will need to take cognisance of the reality that most people with this need are likely to have received primary and secondary schooling that have not adequately prepared them to meet the demands of further studies. Likewise, people requiring access to this kind of educational opportunity most often have an urgent need to earn a living and limited, if any,

disposable income and time to invest in long-term, fulltime educational programmes and courses.

4. A growing emphasis on integrating into PSET programmes and courses with learning opportunities that prepare people to be able to cope with accelerating change, both socially and economically, and thus that emphasise key generic skills such as problem-solving, critical thinking, advanced literacy and numeracy skills, oral and written communication skills, the capacity for ethical reasoning, and the ability to work effectively in teams, among others.

To support South Africa's effective integration in an I4R world and the leveraging of its possibilities to create a country of opportunity for all its citizens, it envisions a PSET system with the following key characteristics (DHET 2020:35-41):

1. Educational opportunities that prepare students who are capable of creative insights, collaborating in diverse social and economic sectors, and navigating through cultural differences, which will provide them with an advantage in the workplace. This will be achieved by embracing curricula that stress multi-, transdisciplinary, and cultural perspectives. PSET education geared towards the I4R will emphasise the acquisition of creative skills, interactive pedagogies, and multidisciplinary perspectives, rather than a narrow focus on the acquisition and transfer of only disciplinary content.
2. Curricula and educational programmes that are responsive to the accelerating pace of technological change. This requires at least some specialised programmes that enable students to comprehend the role and function of technologies, adapt to them, and be able to thoughtfully analyse and predict the evolution of networked systems of technology, the environment, and educational platforms and systems. More broadly, PSET curricula also need to help students develop the capacity for ethical reasoning needed to comprehend the impact of I4R technologies on people and the environment.
3. A system that creates an 'open-loop' education platform in which students can combine building a strong initial education foundation with ongoing educational and skills acquisition opportunities throughout their lives. This would allow them to re-enter PSET at specific points where their skills become outdated and of low relevance or where they wish to advance their lives or careers in response to changing circumstances. The goal of this will be to create a PSET system that is agile in being able to respond to changing educational needs across the life of a person and as the I4R evolves and transforms society.

4. Educational approaches that enable much greater flexibility in terms of how and where students access learning opportunities. This will specifically lead to a greater integration of technology into the provision of educational opportunities as appropriate, taking account of technology access inequalities. The use of technology to support teaching and learning might take different forms according to needs and curriculum contexts, but could include online learning and blended learning courses, the use of MOOCs, the integration of AI into learning delivery to create individualised learning opportunities, the use of simulation and virtual practical demonstrations, flipped classrooms, and online tutoring, among others.
5. A wider and more pervasive application of WIL (work-integrated learning) in PSET, recognising that the workplace is an essential site of learning and that it will be critical to be able to bring PSET to the workplace, given that many students may need to continue working while they study. On-the-job learning approaches offer people the opportunity to learn while they earn, and better integrate theory and practice for better learning outcomes than traditional learning approaches.
6. Accreditation systems that allow students to accumulate 'stackable micro-credentials' throughout a lifelong learning career, which they can acquire while moving in and out of the education system and the workplace and through a diverse and growing range of educational modalities enabled by both ICT and WIL. This form of accreditation will be facilitated by a flexible qualifications framework able to accredit the accumulation of micro-credits across different modalities in an open system of learning and working.
7. Modes of educational delivery that embrace the principles of open learning, as outlined in current PSET policies. Open learning is an approach to education that aims to remove all unnecessary barriers to learning while aiming to provide students with a reasonable chance of success in an education and training system, centred on their specific needs and located in multiple areas of learning. It incorporates several key principles:

    - Learning opportunities should be lifelong and should encompass both education and training.
    - The learning process should centre on the students, build on their experience, and encourage independent and critical thinking.
    - Learning provision should be flexible so that students can increasingly choose where, when, what, and how they learn, as well as the pace at which they want to learn.

- Prior learning, prior experience and demonstrated competencies should be recognised so that students are not unnecessarily barred from educational opportunities by a lack of appropriate qualifications.
- Students should be able to accumulate credits from different learning contexts.
- Providers should create the conditions for a fair chance of student success.

8. Integrated delivery models that work at district and regional levels and that enable PSET institutions in common localities to work with each other, with public and private enterprises, with social structures, with the communities they serve, and with local, district, and provincial governments to create articulated, seamless, responsive education and development opportunities.

Kenya

The new curriculum (2-6-3-3-3)[1] replaced the 32-year-old (8-4-4)[2] curriculum system. The then education cabinet secretary, Fred Matiang'i maintained that there were sufficient stakeholder consultations on the changes, adding that the launch should not be delayed. This is the second time the country is adopting a new curriculum since the 1985 change-over from the 7-4-2-3 curriculum. That model comprised seven years of primary education, four years of lower secondary, two years of upper secondary (form 5-6) and three years for a university course (Wanjala 2017). The system was phased out because it was deemed unsuitable for the changing aspirations of Kenyans and the labour market, which was slowly beginning to embrace technology. The programme focussed on academics as opposed to orienting students for employment. It also failed to cater for the critical pre-primary level of schooling for children under six years. The 8-4-4 system was adopted to seal those gaps, but the curriculum soon came under criticism for churning out school leavers suited only for white-collar jobs.

The argument has been that the curricula neglected the sectors which accelerate economic growth such as agriculture, construction, and fishing. An influx of white-collar job trainees over time created a skills imbalance in the job market, resulting in one of Kenya's biggest obstacles to development – youth unemployment, which currently stands at 40 percent. This ignited

1 It comprises of two years in pre-primary and six in primary school, then three years in upper primary, while 'Junior Secondary (grades 7, 8 and 9) and Senior Secondary Education (grades 10, 11 and 12) will each take three years' (Wanjala 2017).

2 Eight years of primary education is followed by four years of secondary and four years of tertiary education (Milligan 2017).

the desire by the government to include TVET as a key component of Vision 2030. Roughly, Kenya requires 30,000 technologists, 90,000 technicians, and over 400,000 craftsmen to attain the mega projects of Vision 2030. The new curriculum has been touted as the ultimate remedy to the limitations identified in the 8-4-4 system because it is entirely skills-based. Students will not sit examinations, but they will be evaluated through CATs (continuous assessment tests) on the skills acquired as opposed to cramming for examinations as has been the case. Experts are of the view that it will enable students to develop beyond academics and focus on how they can best use their specific talents to make a living. The needs of special needs children have also been incorporated in the curriculum, which will integrate ICT at all levels of education. This new curriculum model places emphasis on the formative years of learning where students will spend a total of eight years – two in pre-primary and six in primary schools. Subjects to be taught in lower primary are Kiswahili, English, Literacy, a mother tongue language, as well as Science, Social Studies, and agricultural activities. Upper primary includes Kiswahili, English, Mathematics, Home Science, Agriculture, Science and Technology, Creative Arts (art, craft, and music), Moral and Life Skills, and Physical and Health Education. Others are Social Studies (Citizenship, Geography, and History) with an option of a foreign language (French, German, Chinese, or Arabic). Junior secondary (grades 7, 8, and 9) and senior secondary education (grades 10, 11, and 12) each takes three years. Twelve core subjects will be taught at junior secondary: Mathematics, Kiswahili, English, Life Skills, Health Education, Social Studies, Integrated Science, Business Studies, Religious Education, Agriculture, Sports, and Physical Education. Learners at this level will also be required to take a minimum of one and a maximum of two optional subjects that suit their career choices, personalities, abilities, and interests. Home Science, foreign languages, Kenyan Sign Language, indigenous languages, Visual Arts, Performing Arts, Arabic, and Computer Science are optional at junior secondary. Learners at senior secondary (ages 15-17) will focus on three areas of specialisation depending on their skills, talents, and interests. These are Arts and Sports Science, Social Sciences, and STEM (Science, Technology, Engineering, and Mathematics). Graduates from this level will have the option to join vocational training centres or pursue university education for three years.

Rwanda

Rwanda has embarked on curriculum reform to improve its quality of education. This is a crucial step in the direction of Rwanda's ambition to 'develop a knowledge-based society and the growth of regional and global competition in the jobs market' (REB 2015). An important shift has been to move away from a knowledge-based to a competence-based curriculum and

from knowledge and skills acquisition to knowledge creation and application. The aim is to develop students' independent, lifelong learning habits, appropriate skills and knowledge, and applications to real-life situations. There is a growing recognition of the potential of competence-based education, unlike traditional subject/content-based education, to develop the capabilities/competencies that are deemed essential for success in both academia and today's knowledge-based economy (Scardamalia, Bransford, Kozma, & Quellmalz 2012).

Rwanda's proposed competence-based curriculum is filled with programmes to develop generic capabilities, such as those discussed by Yeung, Ng, and Liu (2007). The competencies proposed for Rwanda's educational system include critical and problem-solving skills, creativity and innovation, research, communication in official languages, cooperation, interpersonal management and life skills, and lifelong learning. Rwanda has adopted the terms 'competence-based curriculum,' 'generic skills,' 'generic capabilities-based,' and 'competence-based education' (Ngendahayo & Askell-Williams 2016:155-165).

The Rwandan government has refocused its attention on developing and training by transforming its human capital for the socio-economic development of the people in the country through equitable access to quality education, focusing on combatting illiteracy, the promotion of science and technology, critical thinking, and positive values. The curriculum reforms have taken a different direction, which is called the CBC (competence-based curriculum), aligned with the knowledge-based economy or I4R. This is meant to provide students with independent, lifelong learning habits, appropriate skills and knowledge, and an application of real-life situations (Ngendahayo & Askell-Williams 2016).

Nigeria

Nigeria has introduced a new senior secondary education model that emphasises the skills as well as the academic development of students. The skills component of the model is being pursued through the teaching and learning of 34 vocational (trade-based) subjects developed by the NERDC (Nigerian Educational Research and Development Council) and Nigeria's agency for curriculum development. The trade subjects, which are taught together with the academic oriented school subjects, allow students to acquire specific vocational skills in at least one trade area, based on their choice. A fundamental gap was observed after five years of implementing the new education model. It revealed that, while students had learned the trades, they lacked the entrepreneurial skills and ingenuity to deploy the acquired skills for profitable economic ventures.

In 2017, the 34 trade curricula were reformed, and a new trade and entrepreneurship curriculum was introduced to provide students with practical opportunities to acquire entrepreneurial competencies alongside their trade-specific skills, by taking part in in-school, small-scale business ventures, to prepare them better for the world of work. NERDC piloted the revised curricula before attempting a full-scale introduction across the nation. The very helpful piloting stage provided the opportunity to assess the strengths and weaknesses of the curricula before full-scale nationwide implementation.

NERDC is currently taking a critical look at the entire school curriculum with the intention of making it much more responsive to the critical needs of the country. It has developed new contents, including financial literacy education and capital market studies, trafficking in person education and online safety education, that are now being infused into the existing school curriculum. These new contents aim to support Nigeria's drive for entrepreneurship and human capital development in a digitally inclined society. Additionally, NERDC is developing an education in emergency curriculum for the formal education sector to serve the needs of thousands of internally displaced school age children affected by insurgency and other forms of crises. These curricula are designed to enable children to cope mentally and emotionally, and above all, prepare them for reintegration into the formal school system.

Botswana

In its document, Curriculum Programmes, the Ministry of Education describes its primary programme as emphasising the acquisition and application of 'foundation skills, [particularly] 'communication, literacy and numeracy skills, the development of an awareness of the interrelationship between Science, Technology and Society and the acquisition of desirable skills and attributes' (Georgescu, Stabback, Jahn, Ag-Muphtah, & De Castro 2008).

Features of the BE (Basic Education) curriculum of Botswana:

- 10 years of basic education (seven lower and upper primary, plus three lower/junior secondary).
- The five clearly defined components of BE focus explicitly on the development of competencies and skills related to life and work.
- The curriculum framework contains aims that relate directly to the future of students as individuals, community members, and citizens, and address cross-cutting themes such as environmental sustainability.
- Syllabi consistently support the competencies and skills-oriented approaches of the curriculum framework.
- Industry-specific subjects like Agriculture, which are introduced in upper primary (standard 5) reflect local economic circumstances.

- Some professional subjects are available as practical options in junior secondary (standard 9-10).
- Curricula make references to ICT in support of learning.

The components of Botswana's BE are listed as follows in its curriculum framework (Georgescu *et al.* 2008:1-164):

- Foundation skills 'applicable to work situations (decision-making, problem-solving, self-presentation, teamwork, computing).'
- The vocational orientation of academic subjects (related to the real world of work and, where appropriate, applied to various jobs).
- Practical subjects to enhance students' understanding and appreciation of technology, as well as developing manipulative skills and familiarity with tools, equipment, and materials.
- A readiness for the world of work by doing specific subjects (e.g., the study of the subject Commerce).
- Structured visits to companies and simulated work or business activities.
- Career guidance to assist them in identifying their own capacities and interests as well as understanding the labour market.

The general approach of Botswana's BE curriculum is therefore very strongly focused on the development of generic life and work competencies and skills through a range of curriculum design strategies. Botswana's aims and objectives for BE are founded firmly on a base of competency and skills development within a framework of personal growth and personal and social responsibility. The subjects in the lower primary level (standards 1-4) are broad and integrated (for example, Creative and Performing Arts contain the elements of Music, Physical Education, Design, Art, and Craft), but they become increasingly more specific in the upper primary and junior secondary levels.

Key Features of Curricula For I4R

A good education system should be able to address human needs both locally and globally. Education should be regarded as the transformation of human beings for the good of the society, and this can only be achieved through well timed and designed curricula, with the aim to train global citizens (Benešová & Tupa 2017; Reimers 2020; Venkatraman, De Souza-Daw, & Kaspi 2018). Covid-19 has decisively exposed the human inability to deal with uncertainty caused by biological diseases, hence the need to have educational curricula that can foster future scientists in all fields, both locally and at international level.

As the world becomes interconnected, there is a need to harmonise education curricula in some respects to prepare global competent people (Knights, Grant, & Young 2020; Reimers 2020; Jack, Anderson, & Connolly

2014). Therefore, an examination of the selected education curricula portrays some similarities based on what each country needs as well as the global need. Table 2 summarises some of the key skills emphasised in these curricula.

Table 2: Mapping key curriculum contents into I4R skills

Country	Curriculum Contents	I4R Skills
South Africa	Emphasis on problem-solving skills, decision-making, creative thinking, interpersonal skills, communication skills, responsibility towards environment, diversity, critical evaluation of information, and the use of science and technology.	The curriculum adequately addresses both technical and non-technical skills within I4R.
Kenya	Emphasis on ICTs, science and technology, creative arts, moral and life skills, physical and health science, religious education, music, agricultural activities, business studies, sports and physical education, literacy, Kiswahili, English, with a foreign language as option (these are compulsory as from lower primary to junior secondary schools). At senior secondary level (ages 15-17), the focus is on three areas, namely arts and sports science, social sciences, and STEM. Graduates have an option of pursuing the TVET line or university. This is based on CBC.	The curriculum adequately addresses both technical and non-technical skills within I4R.
Rwanda	There is a CBC emphasis on the following: Lifelong learning habits, critical and problem-solving skills, creativity and innovation, research, communication in official languages, cooperation, interpersonal management, and life skills.	The curriculum adequately addresses some aspects of technical and non-technical skills within I4R.
Nigeria	The curriculum emphasises the following outcomes: Financial literacy education, capital market studies, trafficking in person education, online safety education, entrepreneurship, and human capital development.	The curriculum adequately addresses some aspects of technical and non-technical skills within I4R.

Country	Curriculum Contents	I4R Skills
Botswana	The curriculum emphasises communication skills, literacy, numerical skills, science, technology, society, decision-making, problem-solving, teamwork, computing, commerce, identifying students' own capacities, ICTs, agriculture, exposure to the real world of work, and creative and performing arts (outcomes-based curriculum).	The curriculum adequately addresses some aspects of technical and non-technical skills within I4R.

Source: Personal archive

Workplace Critical Skills Development

This section discusses the workplace critical skills development to which education institutions must pay attention in order to prepare the youthful population for I4R workplaces. Critical skills for I4R should not be the sole responsibility of IHEs, but rather a shared responsibility of both employers and educational providers. For example, at the workplace, Chuang and Graham (2018) state that ideally, upgrading the workforce competencies should be done in harmony with the ongoing technological changes. There is a unanimous agreement that employees are the greatest asset to organisations, therefore experts must be active in responding to the influence of technological innovations for the workplace and jobs, as well as the performance of employees, teams, and organisations (Tay *et al.* 2018). This may require practitioners to vigorously investigate the robotic workplace environment, to identify indispensable human attributes and skills, and to anticipate evolving changes in human-to-human interactions that may require applicable HRD (human resource development) initiatives (Branchet & Sanseau 2017; Chuang & Graham 2018). The competitiveness of a country depends on the workforce it possesses as well as its skills sets (Deželan, Hafner, & Melink 2014). The current world presents different competitive playgrounds, where the soft skills and technologies dominate the competitive landscape. Therefore, as Africa ushers in I4R, it will need a skilled workforce with the relevant workplace requirements as set out by digitalised economies. As such, the key important area to which all countries must pay attention is the development of these critical skills sets that will spur both the economic growth and industrialisation brought in by I4R (Fiorelli 2017; Isa 2020; Knights *et al.* 2020).

It is obvious that the types and kinds of available relevant skills, as well as a country's capable workforce will significantly influence its adoption of I4R on both micro- and macro-levels (Maisiri *et al.* 2019:91). On the one hand, the quality of skills and qualifications of the workforce will play a noticeable role in driving the innovation and competitiveness of organisations (Maisiri *et al.* 2019:91; Benešová & Tupa 2017; Mavrikios, Georgoulias, & Chryssolouris 2018), on the other, a lack of the required skills sets will result in a noticeable drop in performance and reduced competitiveness in organisations. Yet, Schallock *et al.* (2018) state that I4R is more than a technological advancement, as it should prioritise human resource development, which involves the development of the skills that will be required in the future (Schallock *et al.* 2018).

Religious Leaders

We live in a religious society, where religious dogmas are quite prevalent. However, wherever there is a need for curriculum change/revisions, the work is assigned to the experts, without necessarily involving the religious leaders. If education is to serve the society inclusively, then it is imperative that religion be part of the curriculum development. Religion influences the behaviour and thoughts of a society, hence assists in the uptake of technologies such as AI and in genetics to, for example improve cattle breeding or crops in the fields. Therefore, their involvement in the curriculum should be noted when developing curricula for I4R.

Non-Governmental Organisations

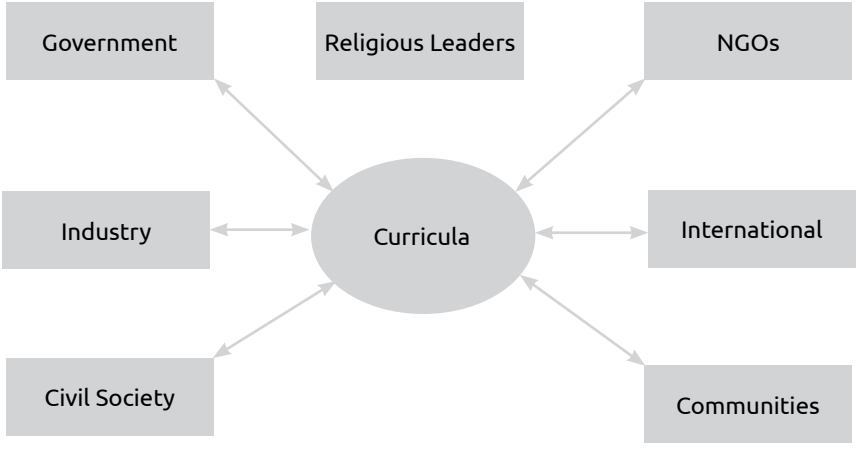
These groups are directly involved in the community activities in support of various developments. They possess first-hand information on the society's needs. Involving them will ensure that education addresses the needs of the society that is to be served. In a nutshell, education must produce what is informed by the society in general as opposed to the current situation. Figure 2 illustrates the relationships.

Industry

The industry has long been recognised as part of curriculum development, specifically with reference to tertiary education. However, its inclusion was mostly limited to just a mere consultation, where the educators had the choice of taking note of their inputs or not. However, we make a strong case for the industry being part of curriculum development, to have more voice. The industry should have a right to dictate on how curricula should be designed and when it should be revised. Education should always serve the need of the industry (Adeosun, Shittu, & Owolabi 2021; Fomunyam 2020). A failure to give them voice in curriculum development is likely to fail the very purpose

for which education is supposed to serve global citizens. Global citizens need to be equipped with the right skills and knowledge to be able to work and live anywhere in the world (Fomunyam 2020). However, this can only be possible if the curricula have an international focus, while being applied locally. Figure 2 demonstrates the dualism in the relation between curricula and the industry.

Figure 2: Curricula for Industry 4.0 Revolution



Source: Personal Archive

Communities

Curriculum development has all along been concentrating on consultation with the industry, but with little input from the communities. Communities are always at the receiving end whenever there are major changes such as natural calamities – drought, famine, floods, and locust plagues, to mention but a few. Having communities' involvement in curriculum development may require that education providers design curricula that provide permanent solutions to many problems and challenges. Such involvement in development will naturally result in problem-solving skills geared towards solving the communities' problems. This relationship is demonstrated in Figure 2 above.

Civil Society

Civil society actors at both national and global levels have developed a substantive capacity and influence in a range of development issues. Partnering with them can help to contribute to the effectiveness of curricula that can address the challenges of the marginalised and vulnerable groups in the society (Naudé 2018). The success of curriculum development and participatory governance depends on both education and an active civil

society with healthy levels of civil engagement. Involving the civil society in curriculum design and development can result in producing people with skills and knowledge needed for the I4R workplace. These are people who fit well within the requirements of the future workplace (cf. Fig. 2).

Government

There is no doubt that governments should play a critical role in the development of education in various facets of life. Governments provide much needed resources that act as seedbeds for education to flourish. Without the help of governments, no education will achieve its purpose or mandate. However, a government can sometimes act as a hindrance to education if the policies are not well and carefully thought through, crafted in line with changes in the society (DHET 2020:35-41 of 67). Good education systems curricula should be driving governments' present and future agendas. Therefore, in this chapter, we appeal to governments to eliminate unnecessary bureaucracies that sometimes result in out-dated curricula (Deloitte 2018). Curricula should move at the pace of the external changes brought about by societal needs through responding to such needs as shown in Figure 2 above. In the following section, the chapter proposes curricula for I4R.

International

The world has become a global village where the rate and pace at which human beings interact, either physically or through technologies, are very frequent. No country can survive in isolation – a challenge confronting one country quickly becomes a world problem, for instance, the Afghanistan case of refugees due to the Taliban war, and Wuhan's Covid-19. Education curricula cannot be designed without the benchmarking with other international communities, as education is supposed to serve humanity irrespective of its location. The involvement of other international communities in the curriculum development of one community, is paramount to enable education to add value and serve humans better. Figure 2 attempts to show the components of curricula for I4R that can be used to develop critical and knowledge-based skills for sustainable development in Africa. Whereas this involvement is vital, it is also imperative that African countries think globally, while acting locally for such curricula to be of benefit to humanity.

Future of Africa in Industry 4.0 Revolution and Beyond

The future of Africa seems to be well based on the analyses of the current education curricula. Employability in I4R will depend on how education institutions are implementing these technical and non-technical skills to students in preparation for readiness in the workplace. Identifiable skills

needed for I4R across major sectors such as communication, problem-solving, decision-making, analytical and critical thinking, synthesising information, teamwork, interpersonal skills and continuous learning, numeracy, Science, Mathematics, and ICT will be the key success factors for a knowledge-based economy (Kayembe & Nel 2019). Therefore, education institutions will have to ensure that their current curriculum development addresses the following factors for I4R and beyond:

- Joint curriculum development between the education sector, civil society, communities, religious leaders, government, and private and non-governmental organisations. The emphasis should be on the cocreation of curricula, not only consultation as has been the norm when such curricula are designed. This will ensure that most of the graduates will be capable of entering the world of work, ready to be absorbed or ventured into entrepreneurship (cf. Fig. 2).
- The curriculum development must address both local and global needs, given that the world is interconnected. This will prepare graduates to be globally ready for both local and international assignments (Naudé 2018:16 of 22).
- Flexibility in the development of curricula to allow for changes, as global changes have impacts on the education systems. Most of the curriculum revisions take approximately five years, while the external changes take place every day. It would therefore be appropriate that the current curricula adapt to these changes when necessary to address the missing links in the labour markets.
- Education institutions need to move away from the traditional programmes and embrace the new imperatives such as STEM, ICT, entrepreneurship, creative and performing arts, and other life skills hinged upon students' capabilities and abilities.
- Africa has numerous natural resources and a youthful population. However, a lack of critical knowledge in exploiting these resources for the betterment of the continent has resulted in the exploitation of it by foreign organisations. Infusing subject specifics such as STEM, ICT, and life skills, will empower the youths to exploit these resources for the good of the continent.
- Curricula should be designed to suit and focus on three areas of specialisation, depending on students' skills, talents, and interests, while not ignoring Arts and Sports Science, Social Sciences, and STEM.
- The future belongs to the technology-oriented workplace; hence waiting to embrace technology until students reach senior school or tertiary levels, will be ill informed. The curricula should be designed with the future in mind, and preparing young children to embrace technology as early as kindergarten should be a must to address the future of the workplace. The

use of ICT and MOOCs will facilitate the non-discriminatory participation in developing skills required for I4R, in addition to using cyber-physical education for developing skills and building competencies of students and educators across the continent. In fact, leveraging on the power of I4R, African countries can tap into the knowledge base of most advanced countries' education without necessarily having to send students abroad.

- Strengthening TVET to cater for those students who could not gain direct entry into universities. TVET offers much-needed skills and knowledge that are critical for survival in I4R.
- Embrace smart teaching technology from the lower level of education. Such technology will not only be limited to learning and skills development in both real and virtual worlds, using AR and VR, but also integrating the IoT and AR technologies in educational institutions' laboratories to develop skills required in I4R.

Future Knowledge and Skills Development

I4R has also created a window of opportunity for education to be offered through ODL, using a variety of gadgets to prepare students for the 21st-century workplace. Such gadgets that are currently in application in providing education through both ODL and conventional education systems, particularly during Covid-19, are e-materials/e-SLMs, MOOCS, OERs, LMSs, and the evaluation of learning materials which have been included in the training curricula. Today, with the digitalisation of educational contents, students can access their learning material anywhere and anytime, hence bridging the geographical space, as the world becomes one global village through I4R. These transitions have not only challenged the human beings to interact with one another, but they have created a 'shared economy.' African countries need to develop its own human capital skills and knowledge base to be competitive at international level through the right education curricula that have an international tendency but are implemented locally. Similarly, with the I4R as background, countries and organisations can develop critical skills and knowledge for the future.

Research indicates that the global economy will have a shortage of 40 million workers with tertiary education, a shortage of 45 million workers with a secondary education, and a surplus of 95 million low-skilled workers during the third decade if the 21st century (Deloitte 2018:15). Deloitte's study found that not all these deficits and surpluses are distributed equally on a global level. For instance, China alone is expected to have a deficit of 24.5 million workers, while sub-Saharan Africa's workforce will soon reach 20 percent, double of the total global workforce it had in the early parts the second decade of the 21st century (Strack, Baier, Marchingo, & Sharda 2014). To address the

challenges and demands for future jobs and skills in the I4R environment, the education sector in Africa should focus on and move away from the current traditional education systems to embrace education systems that address I4R knowledge and skills requirements. It is well recognised that I4R implications for workforce transformation and shifts in workforce will impact the future of work and education systems of nations (Adeosun *et al*. 2021).

African governments have been developing their human capital using traditional methods of the classroom, where the success of a student is judged by how well that student passes formative and summative assessments, based on the courses or syllabi taught. This approach had some gaps because it only relied on the subjects that could be taught in classrooms. However, with the shift to I4R job requirements, some knowledge and skills cannot be developed in classrooms alone. For instance, Fomunyam (2020:27) points out that the 'current curriculum used in African higher education is old, and mostly irrelevant to the demands of the I4R, and most of the contents of curriculum cannot equip students with necessary skills to perform in organisations of the future.' Fact is that the current content of curricula used in African HE does not match the current labour market demand and/or development needs. This has created a dissonance between the curricula needed and demands of employers in the I4R. To develop Africa's knowledge and skills base fit for I4R workplace requirements, proposals have been made to reconfigure education curricula to allow for students to develop capacity in the event of this rapidly emerging areas of genomic, data science, AI, robotics, and nanomaterials (cf. Fomunyam 2020:28; Penprase 2018). African education systems must inculcate the digitisation of the I4R, to ensure that employees are knowledgeable on the newly developed organisational technologies (Fomunyam 2020:28).

Therefore, Africa, given its growing young population, must develop knowledge and skills for its workforce, using excellent curricula that are fit for purpose, focusing on I4R workplace requirements. African governments must invest significantly in the knowledge base generation and workers through schooling and re-tooling, to find occupations less susceptible to automation, that expose workers to being replaced by automation due to the lack of relevant education and skills (Naudé 2018:13 of 22). In light of the foregoing debate, we propose that African governments should focus on the following key areas for future development of knowledge and skills to participate in the I4R economy:

- First, African governments must understand the advantages and disadvantages of I4R and apply its technologies and products on education to quality students who have the competencies and skills to comprehend future challenges and try to solve them. This will require the integration of disciplines such as STEM. In addition, there must be an

integration between the educational system elements, namely education policy, teachers, curricula, learning environments, students, and industrial sectors in society. This will assist in preparing the future generation for I4R workplace requirements.

The educational sectors will benefit a lot from such integration of curriculum design and instructional activities that will qualify the students to have future jobs because in future, the problem could not be the lack of jobs, but rather, a shortage of skills that will depend completely on I4R ideas (Elayyan 2021:28; Deloitte 2018:22). Industry-university collaboration in curriculum development will help in eliminating mismatches in knowledge and skills with what industries need (Deloitte 2018:22). Naudé (2018:15 of 22) adds that private sectors' involvement, through for instance advice on curriculum reform, internships, on-the-job training, and (co)-funding of educational infrastructure, are some examples of the learning environment that needs to be scaled up to help develop knowledge and skills for I4R workplace requirements.

- Second, developing skills for future work is complicated and not a simple one. For instance, it is predicted that people such as engineers, programmers, doctors, waiters, etc. will lose a lot of jobs, and new jobs will emerge like robot technicians, BDA analysist, AI experts, blockchain designers, and 3D-printing engineers. However, this loss can be minimised by transforming knowledge skills to liquid or soft skills. Training and development may require that students' right brain skills be developed to have skills such as technical skills, critical thinking, coordinating with others, verbal communication skills, and time management (Elayyan 2021:28). In addition, students studying basic and applied sciences also need to understand the political and social nature of the world in which they live (Butler-Adam 2018:1 of 1). I4R borrows from a wide range of disciplines and this requires that IHEs should infuse students with different combinations of courses away from discipline specific courses in which they specialise.
- Third, training and development of educators with knowledge and skills on the applications of technology in teaching should be a priority of any government to enhance teachers' ability to implement some of the features of I4R in learning institutions. Research has found that the education sector in Africa is not fully prepared for I4R, however, by transforming knowledge and skills of educators, can assist in harnessing the potential of the anticipated I4R workplace. This will foster education for sustainable development through the application of principles of teaching and learning activities, hence transform the workplace to meet the need of I4R.

- Fourth, change in education institutions should emphasise the need to shift towards the imparting of complex, problem-solving, creative, and social skills, including management, leadership, change management, collaboration, critical thinking, curiosity and risk taking, communication, marketing, and sales, all which are required for entrepreneurship (Naudé 2018:16 of 22).
- Fifth, education-based models such as dual-education apprenticeship models seek to ease the transition between education and the workforce by providing students with on-the-job skills training while competing their formal education (Deloitte 2018:22; Naudé 2018). These models have been found to be platforms that businesses use for direct pipeline hiring with the opportunity to pre-screen candidates, lower the cost of recruit training without entering a formal employment process, and promote their corporate social responsibility objectives in the marketplace.

Conclusion

Africa faces unprecedented challenges as it grapples with the challenges and opportunities presented by the 4IR requirements. These challenges have now been thrown into sharp relief by the Covid-19 pandemic and associated socioeconomic disruptions, such as the recent credit downgrades. Within these highlighted challenges, though, lies an enormous opportunity, provided we act with purpose and intent, to redevelop our society and economy on a new basis, in ways that are just, equitable, inclusive, and sustainable. The I4R offers the continent many tools to support this redevelopment, as does the provision of high-quality education systems and relevant opportunities for Africans. For Africa to seize this opportunity, though, it will be necessary to reinvent its education systems, so it can fulfil its true potential as a vehicle for social development and wealth creation for all Africans. All these cannot be achieved through slow, incremental change. The economic headwinds which the continent faces, and the relentless pace of technological change precipitated by the I4R mean that the continent must respond in kind, with purpose and speed. To accomplish this, will require a willingness to reconsider many of the core principles and operational models on which the education system is currently based. This can be done, but will require a binding social contract from many key stakeholders in the African society.

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Chapter 8

Higher Education for Pluriversal Diplomacy: Landing the 4IR on Habitable Earth

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Introduction

In the face of the rapidly advancing discourse and reality of the 4IR (Fourth Industrial Revolution), forward-looking practitioners in HE (higher education) began to warn that HE's responses to the 4IR 'have been slow and inadequate' (Gleason 2018:5), and 'to stay relevant in this new economic reality, higher education needs a dramatic realignment' (Aoun 2017:xii). This warning, however, is mostly *reactive* in the sense of accepting the 4IR as the external imperative to which HE must adapt: Given that '[w]hen the economy changes, so must education' (Aoun 2017:xvii), it is now inevitable for IHEs (institutions of higher education) to adopt 'policies and programs to prepare 4IR-ready citizens' (Gleason 2018:9). Such a reactive call for HE reforms has grown only louder since the onset of the Covid-19 pandemic. With the accelerating use of digital technologies – the main drivers of the 4IR – in various domains of the wider society, including but not limited to healthcare, transport, commerce, and manufacturing (Deloitte Development LLC 2020; Schwab & Malleret 2020:151-171), how to digitally transform HE to adapt to the 'new normal' (Gallagher & Palmer 2020; Times Higher Education 2021) has become a focal question in the ongoing HE debate on the 4IR.

There is a minority of scholars in the HE debate who advances a more *proactive* position, aiming to intervene in the 4IR by creating 'a forward-looking framework which enables education and research to actively shape the future of work' (Peters & Jandrić 2019:411). Even this proactive mode of thinking is rarely *critical* in the sense of probing deeply into the 4IR's potential negative impact. Although the proactive mode takes seriously 4IR-related job losses and inequalities in the short run (Peters 2017), it fails to investigate, as it were, the 4IR's 'Achilles' heel' – its impact on Earth (cf. Müller 2018 for a notable exception). As demonstrated by growing research on climate change, intensifying energy use by humans since the 1IR (First Industrial Revolution) has contributed to the drastic increase of CO_2 in the atmosphere and caused

much damage to the natural environment (Bonneuil & Fressoz 2016; Newell & Paterson 2010). Put bluntly, what is the point of transforming HE for the 4IR if much of Earth becomes uninhabitable as the result of successive waves of industrialisation?

Indeed, 4IR advocates are now aware of this simple truth: No Earth, no 4IR. Even the most vocal 4IR advocate, the WEF (World Economic Forum) recently conceded that the potential of 4IR technologies to tackle climate change 'is far from being reached' (WEF 2020a:4) and recalibrated its 4IR advocacy by creating the '2030Vision' platform to channel 4IR technologies toward climate action and other SDGs (Sustainable Development Goals) (WEF 2021a:3-4). However, to what extent will the proposed platform succeed in internalising the 'hazards,' 'hybrids,' and other negative consequences for Earth that the modern industrial world has systematically externalised (Beck 1992; Latour 1993)? Can the 4IR really land on Earth instead of another planet – real or imaginary (cf. Latour 2018:5)? These questions are critical at today's juncture, as the global economy has begun to recover from the pandemic, sharply rebounding the global CO_2 emissions to their highest ever level (International Energy Agency 2022).

I suggest that the HE debate should first address these critical questions about climate change as the ultimate horizon of the 4IR. Only then, HE practitioners can start meaningful conversations on how HE should respond to the 4IR. I specifically propose to reframe the ongoing debate in terms of HE's *public contribution* to preserving *habitable Earth as the common good*. Thus reframed, HE's public contribution can be articulated with two dimensions.

First, IHEs should contribute to the production of climate-change knowledges that enable the public to critically examine the compatibility between the 4IR and habitable Earth. Even in today's so-called post-truth world, expert knowledges continue to matter, not simply because the role of experts has been institutionally legitimated in modern societies (Brint 1994; Stevens, Armstrong, & Arum 2008), but also because they usefully inform policy deliberation on highly technical issues (Jasanoff & Simmet 2017; Nichols 2017). In this regard, it is crucial for HE-based researchers to investigate whether and how the 4IR can really preserve habitable Earth as the common good, and freely share their knowledges with the public.

Second, IHEs should serve as focal sites in the public sphere (Calhoun 2006; Delanty 2001) in which stakeholders, such as policymakers, business leaders, and concerned citizens, can come together to debate the compatibility between the 4IR and habitable Earth. Precisely because both the 4IR and climate change are vastly complex phenomena, HE-based researchers will likely produce heterogeneous and even contradictory knowledges – this is why it is imperative for IHEs to refrain from imposing 'facts' on the stakeholders,

in this way short-circuiting their 'pluriversal diplomacy' (cf. Dunford 2017; Latour 2017). This second dimension of HE's public contribution therefore complements the first one in facilitating, rather than adjudicating, public debates with the latest knowledges of the 4IR and climate change.

To reframe the ongoing debate around HE's public contribution, I believe this volume's focus on Africa helps greatly, for it forcefully foregrounds the dimension of *geohistorical justice* in the 4IR and climate change. As historians and social scientists have shown, the 1IR was coterminous with the colonisation of Africa – the exploitation of its people and natural resources – by the West (Inikori 2002; Nunn 2008). Consequently, the legacy of Western dominance has persisted in the form of neocolonialism and other power asymmetries, foundational to the political and economic order of today's world (Doyle 1986; Steinmetz 2014). Even worse, this geohistorical injustice can be doubled when the West refuses to take responsibility for their past CO_2 emissions that disproportionately contributed to climate change (Newell & Paterson 2010:11-35). In this regard, African perspectives on the relation between the 4IR, climate change, and geohistorical justice have the potential to open up new lines of critical inquiry into how HE's public contribution should be re-envisioned on a global scale.

Rethinking the Fourth Industrial Revolution in Light of Climate Change

Such worldwide re-envisioning is needed because the debate on the 4IR has been globally promoted by the WEF and disseminated through WEF-based networks of influential business leaders and policymakers around the world. Although the 4IR as both discourse and reality is ever-evolving and hard to pin down, the WEF executive chairman, Klaus Schwab (2016:8) originally characterised it as a confluence of 'multiple technologies that are leading to unprecedented paradigm shifts in the economy, business, society, and individually.' These technologies typically include AI (artificial intelligence), robotics, the IoT (internet of things), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, and quantum computing. Because it enables new ways of integrating 'the physical, digital and biological worlds, [the 4IR] is not only changing the "what" and the "how" of doing things but also "who" we are' (Schwab 2016:7-8). Given this profound and far-reaching impact of the 4IR, Schwab insisted that all stakeholders should 'examine [themselves] and the underlying social models that these technologies embody and enable,' so that the 4IR would be 'empowering and human-centred' (Schwab 2016:9).

Then, the discourse and reality of the 4IR accelerated during the Covid-19 pandemic. AI and mobile data collection tools have been deployed for contact tracing and predicting the spread of the disease in populations,

nanotechnology, and biotechnology for the development of mRNA-based (messenger ribonucleic acid-based) vaccines, and 3D printing for producing medical devices and equipment (Signé, Khagram, & Goldstein 2020), while digital technologies have normalised remote work across different sectors of society (McKinsey & Company 2020). The deployment of these 4IR technologies in pandemic preparedness and response has led to the celebration of the 4IR's potential to not only 'beat Covid-19' (Walcott 2020) but also to make businesses and governments more agile and resilient for the post-pandemic world (Lacina & Sault 2021; United Nations Industrial Development Organization 2020).

As Schwab (2021:145) recently warned, however, 'even if we get the Fourth Industrial Revolution right, there is still another global crisis we need to address as well: the ongoing climate crisis.' This is a significant departure from the WEF's previous publications that had emphasised the 4IR's positive contributions to 'radically transform the management of our environmental surroundings' (WEF 2017:8), while only minimally acknowledging its potential negative externalities. Now Schwab (2021:161-162) has openly admitted that energy-intensive 4IR technologies, such as blockchain, robotics, AI, and IoT, were 'so far adding to the ever-expanding human footprint on the environment, [and that] while connected devices make our energy infrastructure smart, that doesn't automatically mean it turns green as well.' This admission came against the backdrop of the growing recognition that the climate crisis was deepening. As the global economy seeks to exit from the pandemic, how many of the carbon-intensive infrastructures, assets, and human behaviours can be shifted down in the coming years, will decisively shape the future of humanity and Earth (Markard & Rosenbloom 2020; United Nations Environment Programme 2020).

Despite their recognition of the 4IR's negative externalities, 4IR advocates like Schwab continue to believe in the promise of 4IR technologies to reduce CO_2 emissions and accelerate the worldwide energy transition toward decarbonisation (WEF 2021b) because, '[u]sed for the right purposes, computers and other smart devices can help save energy and resources, rather than consume more of them' (Schwab 2021:162). Such confidence in the human ability to master science and technology for a better world seems to have been cemented among the 4IR advocates since the WEF launched the 'Great Reset' initiative to take the pandemic as the opportunity for harnessing 4IR technologies to radically transform the economy into a more sustainable one and hence to avert a 'climate catastrophe' (Schwab & Malleret 2020; WEF 2020b). Alongside this initiative, the WEF and its partners also have begun to expand the scope of their advocacy to comprehensively mobilise 4IR technologies to solve all major global challenges, namely SDGs that

include climate action and other goals for environmental protection (WEF 2020a, 2021a).

Here, these 4IR advocates effectively reinforce the 'spirit of modernity' – '"we" understand better the very nature of nature in a way past societies could not see' (Bonneuil 2015:26) – and hence reaffirm their faith in science and technology as the means to master Earth and solve the problems of sustainable development. Nevertheless, it is exactly this modernist faith that set in motion the successive waves of industrial revolutions to produce and externalise invisible and unintended hazards of scientific and technological progress (Beck 2008), ultimately causing the climate crisis that now threatens the existence of humans and other species on Earth.

Moreover, the modernist faith not only denies the long-term and unintended side effects of scientific and technological progress (Beck 1992), but also naturalises the sharp separation of 'humanity' from 'nature' (Latour 1993). Take, for example, Schwab's initial emphasis on the 4IR's 'human-centeredness': Positing Earth-as-a-passive-object to be managed by humanity-as-an-active-subject, he celebrated that 'the fourth industrial revolution will greatly increase our ability to address negative externalities' on Earth and advocated that this increased ability should be fully embraced because it could 'boost potential economic growth' for humanity (Schwab 2016:36). Even though Schwab (2021:176) has recently elevated Earth to 'the central stakeholder in the global economic system [and argued that] its health should be optimized in the decisions made by all other stakeholders,' his global stakeholder model continues to keep 'people and planet' as separate entities. In reality, however, humans are interdependent with Earth's life-supporting mechanisms, including but not limited to certain chemical compositions of air, water, and soil. 'Human' is never an actor, independent of their natural environment, but only an *actor-network* whose existence is distributed far beyond the boundaries of their biological cells, and hence enabled by numerous connections with nonhumans that make up Earth (cf. Latour 2004, 2017).[1]

At the deepest level, then, rethinking the 4IR in relation to climate change, calls into question the modern ontology of humanity-versus-nature as well as the modernist faith in science and technology. Put another way, if climate change is the consequence of modernity *per excellence*, can the 4IR – the latest expression of 'the spirit of modernity' – really offer an effective solution? Will the 4IR-driven Great Reset ever succeed without simultaneously 'resetting modernity' (Latour & Leclercq 2016)?

1 Thich Nhat Hanh (2017), a Buddhist monk and peace activist, illustrated this relational conception of humanity as 'interbeing' throughout his long teaching and writing career.

Higher Education's Response: Reactive, Proactive, and Critical

Rather than raising these critical questions to probe the limits of the 4IR, a majority of HE practitioners seem to have already accepted the 4IR as the external imperative to which HE must adapt, thinking that it is the only way to maintain HE's relevance in the fast-changing world. Such a *reactive* mode of thinking manifests in two of the major contributions to the HE debate on the 4IR to date: *Robot-proof: Higher education in the age of artificial intelligence*, by Joseph Aoun, the president of Northeastern University, and *Higher education in the era of the Fourth Industrial Revolution*, edited by Nancy Gleason, former director of the Centre for Teaching and Learning at Yale-NUS. To begin with, Aoun (2017:xv) observed that 'the existing model of higher education has yet to adapt to the seismic shifts rattling the foundations of the global economy,' increasingly driven by AI, machines, and other 4IR technologies. He reached this realisation while carefully studying the 'views from the C-suite: what employers want, in their own words' (Aoun 2017). Similarly, in the introduction to her edited volume, Gleason extensively surveyed the reports on the future economy and work by the WEF, McKinsey Global Institute, and other business-knowledge producers, and argued that 'HE needs to change to better prepare thinkers of the 4IR' in the ever more automated, digitised, and technology-driven world (Gleason 2018:5).

Ultimately, the reactive mode of thinking by Aoun and Gleason stems from their shared assumption that the primary purpose of HE should be *vocational* and *instrumental*, 'to prepare students for fulfilling – and successful – roles in the professional world' (Aoun 2017:xv) and 'to prepare them for a productive life' (Gleason 2018:5). Here, coterminous with their emphasis on HE's vocational and instrumental value, is their focus on its *private-good* aspect, in which *individuals* are to be educated to expand their cognitive capacities for working successfully with machines and other 4IR technologies. According to Aoun (2017:xix), these cognitive capacities include systems thinking, entrepreneurship, cultural agility, and critical thinking, among other 'higher-order mental skills.' Building on Aoun's observation, Gleason (2018:6) also urged HE to help students to acquire creativity, cognitive flexibility and agility, and other elements of 'the higher order thinking that is needed in the 4IR.' For both Aoun and Gleason, these higher-order thinking skills constitute the essential traits of successful learners who can keep upskilling themselves to stay employable in the 4IR-driven world.

This reactive mode of thinking has only intensified since the pandemic stimulated the discourse and reality of the 'digital transformation of HE.' For example, Sean Gallagher, Executive Director of Northeastern University's Center for the Future of Higher Education and Talent Strategy, suggested that because HE 'has significantly lagged behind other industries' in digital

transformation, HE leaders and policymakers should embrace the pandemic as an opportunity for creating 'digital "credentialized packages" of learning and mastery valued by employers' (Gallagher & Palmer 2020). Similarly, Times Higher Education (The World University Rankings 2021; cf. Mihai, Cheung, Bali, & Wigham 2020) has organised forums and events to explore how digital and other 4IR technologies could help IHEs to innovate teaching and learning to better support lifelong upskilling.

To be sure, the reactive mode of thinking is rightly student-centred because one of the most immediate and urgent concerns among students is how to make a living upon graduation, for modern education systems have institutionally coupled schooling with occupation at the societal level by validating academic credentials as the proxies of competence while distributing it unequally in the population (Bourdieu 1983; Meyer 1977). Such an institutional linkage between schooling and occupation has further been reinforced worldwide by policymakers and business leaders who regard education as an essential means of economic growth (Schofer & Meyer 2005). Thus, the emphasis on the vocational and instrumental value resonates, at least partially, with HE's publicness: By increasing the individual graduate's employability (human capital *cum* private good), HE contributes to the public, albeit narrowly defined in economic terms.

Ultimately, however, the reactive mode of thinking disempowers HE by leaving it no choice but to adapt to the parameters set by the economy. Given the dominance of this mode of thinking, a significant part of the HE debate on the 4IR simply accepts the agendas promoted by the WEF and other thought leaders in business and government, instead of asking how HE can actively reshape the agendas. In fact, the reactive mode of thinking has prevented HE practitioners from keeping up with the frontier of the 4IR debate on climate change: Although they make brief references to climate change, they never thematise it as a focal point of the HE debate on the 4IR (e.g., Aoun 2017; Gleason 2018).

Nevertheless, a more *proactive* approach has been advocated by a minority of HE practitioners. For example, the Universities of the Future project, co-founded by IHEs, companies, and the Erasmus+ Programme of the European Union (Universities of the Future 2020:iii of 60), observed that '[t]here are two main approaches that educational systems may take towards I4.0 (Industry 4.0): Educating followers or change makers.' Instead of educating followers of the 4IR, the initiative set out 'to identify skills that are essential' for educating change makers who could lead the 4IR in an innovative fashion. Along the same lines, Michael Peters and Petar Jandrić (2019:408) proposed a new model of HE – 'the creative university as the digital public university' – to intervene in the 4IR and actively shape the future of work based on the following principles:

> 1) User-centred and open-innovation public knowledge ecosystems. 2) Shared ethos underlying 'co-production,' 'co-creation,' 'co-design,' and 'co-responsibility.' 3) New platforms to utilize collective intelligence and commons-based peer production. 4) Focuses on the links between openness and creativity; design and responsibility. 5) Radical openness, interconnectivity, and interactivity – shift from industrial broadcast media (one to many) to new social media (many to many) (Peters & Jandrić 2019:408).

This proactive mode of thinking thus aims to position IHEs as coparticipants in the 4IR along with businesses, governments, citizens, and other stakeholders.

Yet, the proactive mode of thinking shares with its reactive counterpart the modern ontology that externalises and dumps the unintended consequences of scientific and technological innovations into 'nature.' For example, although Peters and Jandrić (2019:403) have foregrounded 'technological unemployment' as one of the short-term negative externalities of the 4IR that 'destroys more jobs than it makes,' their perspective remains decidedly modern and human-centric, failing to consider climate change as well as other environmental problems that are already threatening the very existence of humanity on Earth. The fact that even the proactive mode of thinking trails behind the latest 4IR debate on climate change may well vindicate Schwab's criticism of 'research conservatism in academia' that makes HE practitioners unfit for working with other stakeholders to pursue 'forward-thinking ideas' for the 4IR (Schwab 2016:27).

In this regard, Eduard Müller's work is an exception because it *critically* examines the relation between HE and the 4IR, starting with the recognition that Earth is in trouble because humans 'have promoted degenerative development with massive resource extraction' (Müller 2018:130). To prevent the 4IR from exacerbating degenerative development, Müller urged HE institutions to incorporate into their research, curriculum, and administration the idea of 'regenerative development,' i.e., reconstructing the existing measures of development that disregard environmental degradation, empowering local knowledge and participation in environmental governance, and strengthening people's environmental consciousness. Müller's mode of thinking is not only proactive but also critical in the sense of probing how HE can and should reshape the 4IR so as to keep Earth habitable. Such a critical mode of thinking is indispensable because, for the foreseeable future, climate change will remain the ultimate horizon of all economic, political, and social challenges around the world (Beck 2016). Although economic inequalities, refugee crises, racism, pandemics, and many other contemporary problems are all urgent in their own light, how effectively they can be addressed and resolved in the long run will fundamentally depend on how much of Earth can

be kept habitable. Here, HE practitioners have an urgent task – to promote and expand this critical mode of thinking in the HE debate on the 4IR by bringing climate change into the equation.

Higher Education for Habitable Earth as the Common Good

To this end, I propose to reframe the ongoing HE debate on the 4IR from the vantage point of *habitable Earth as the common good*: Without habitable Earth, neither the 4IR nor HE can be sustained. This reframing also foregrounds the fundamentally public nature of HE itself (Marginson 2016; Saito 2018, 2019), going beyond the reactive and proactive modes of thinking that are primarily concerned about individual employment outcomes as private goods. Put another way, what kinds of public contributions might HE be able to make in critically reshaping the trajectory of the 4IR for habitable Earth?

I argue that the first public contribution of HE will revolve around the production of knowledges about climate change, including the 4IR's climate impact. In fact, climate change is an exceedingly complex phenomenon, consisting of ecological, technological, economic, and many other components that spatially encompass the entire globe (Beck 2016:99). The production of knowledges of such a phenomenon thus requires the mobilisation of scientists, instruments, laboratories, and facilities that are simultaneously dispersed and networked across national borders (Edwards 2010). Here, IHEs are best positioned to mobilise these sociotechnical infrastructures for the production of climate-change knowledges because the expansion of professional associations of HE-based researchers, as well as the internationalisation of IHEs, has created extensive networks of multinational research collaborations (Drori, Meyer, Remirez, & Schofer 2002).

Moreover, IHEs and their research activities are organised around the logic of 'truth,' in contrast with other knowledge producers, such as corporations and governments that operate according to the logics of 'money' and 'power,' respectively (cf. Friedland & Alford 1991). This institutional logic of HE-based research enables the production of climate-change knowledges that are scientifically more rigorous and less burdened with conflicts of interest. Indeed, because the function of IHEs as the most legitimate knowledge producers has been firmly institutionalised in modern societies (Brint 1994), corporations, and governments as well as think tanks and foundations, including the WEF, need to work with HE-based and HE-trained experts. In this regard, I suggest that IHEs embrace their epistemic authority as 'temples' of modern societies (cf. Meyer 2000; Stevens *et al.* 2008) and actively participate in the ongoing debate on the 4IR by providing stakeholders with the latest knowledges of the 4IR's climate impact.

At the same time, it is crucial to emphasise that IHEs-as-temples are deeply implicated in worldly struggles for the power to shape the trajectory of the 4IR *vis-à-vis* the future of Earth. Not only researchers in science and technology studies (Jasanoff 2006; Jasanoff & Kim 2015) generally acknowledge that knowledge and power are co-produced, but also Ulrich Beck (2016:96; original emphasis) specifically observed that 'the politics of global risk [e.g., climate change] is, first of all, intrinsically a *politics of knowledge*.' While HE-based researchers may think that they simply describe and explain the 4IR's climate impact, they are in fact shaping the politics of climate change by providing policymakers, business leaders, NGOs (non-governmental organisations), and other stakeholders with conceptual models and empirical findings as rationales for justifying their positions on the compatibility between the 4IR and habitable Earth. Because HE-based researchers inevitably play such a performative role in the politics of climate change, their affiliated institutions become 'obligatory passage points' (Callon 1984) for stakeholders who want to advance their own positions.

However, to what end should this performative power of IHEs-as-temples be deployed, or to which direction should IHEs-as-obligatory-passage-points steer the politics of climate change? I suggest that the performative power of IHEs should be deployed to move the politics of climate change in the direction of *pluriversal diplomacy*, 'a negotiation that can begin precisely only because there is *no longer a higher arbiter* – neither power, nor law, nor nature' (Latour 2017:259; original emphasis). The starting point for such pluriversal diplomacy is the recognition that different stakeholders, advancing different positions on the compatibility between the 4IR and habitable Earth, live in different realities, i.e. *the plurality of universes*. Only when stakeholders fully understand how radically different they are, they can finally start a peaceful negotiation for peace, for the non-recognition of difference by one party can breed indifference to, disrespect for, and violence to another party.

To this end, IHEs should provide all stakeholders with the latest research findings about the 4IR's climate impact with all its complexity, ambiguity, heterogeneity, and even contradictions: Such 'epistemic pluralism' can be consciously advanced through, for example, more inter- and transdisciplinary research that foregrounds the diversity of perspectives as well as '[a]lternative research methodologies, such as participatory action research,' by which HE-based researchers and other stakeholders collaborate to co-produce knowledges (UNESCO 2022:15). Here, accepting the plural realities of the compatability between the 4IR and habitable Earth, is the first step in preparing the stakeholders for an arduous negotiation that aims to gradually unify their multiple universes to the extent that they can coexist peacefully on, and with Earth. Importantly, this kind of peace is '[n]ot a *pedagogical* peace obtained through the older science-*versus*-politics repertoire [where]

war is simply the irrational mistake of those who have not understood the laws of nature or of economics' (Latour 2015:153; original emphasis). That is, IHEs as temples of pluriversal diplomacy only facilitate the open-ended, collective exploration of peaceful coexistence among all stakeholders on Earth, rather than pre-empting such exploration through the imposition of 'scientific truths.'

This role of IHEs as the facilitators of pluriversal diplomacy points to the second kind of their public contributions, i.e., to serve as focal sites in the increasingly global public sphere for critically debating the compatibility between the 4IR and habitable Earth (cf. Calhoun 2006; Delanty 2001). This is possible because, as UNESCO (United Nations Educational, Scientific, and Cultural Organisation) (2022:20, 60 of 101) rightly recognised, HE is institutionally 'open to novel and critical thinking [and therefore] the ideal setting for pluralizing views of the world… by way of dialogue with different sectors of society and with different ways of knowing.' Then, through international symposia, forums, webinars, and many other events open to the public, IHEs can jointly create discursive spaces and networks for relevant stakeholders to come together across national borders to exchange their plural views on the 4IR's climate impact.

In so doing, however, IHEs must specifically be conscientious to prevent power relations among different stakeholders from prematurely concluding the collective exploration of peaceful coexistence on Earth. Put another way, peace should not be pursued at the expense of justice, as Judith Shklar (1990:118) remarked, 'We often choose peace over justice, to be sure, but they are not the same. To confuse them is simply to invite passive injustice.' In the context of climate change, this means that humanity's joint effort to obtain peace with Earth should not ignore injuries that one group of humanity has inflicted on another:

> Behind the cosy language used to describe climate change as a common threat to all humankind, it is clear that some people and countries contribute to it disproportionately, while others bear the brunt of its effects. What makes it a particularly tricky issue to address is that it is the people that will suffer most that currently contribute least to the problem, i.e. the poor in the developing world (Newell & Paterson 2010:7).

Here, the question of peaceful coexistence on Earth is 'directly tied to questions of injustice and inequality' (Latour 2018:3).

This question about justice in the context of climate change is fundamentally *geohistorical* in the sense that '[t]he industrial development model and its metabolism in terms of matter and energy, which altered

the geological trajectory of our Earth, is inseparable from the history of capitalist world-systems, of unequal ecological exchange, of colonialism and imperialism, of exploitation and underdevelopment' (Bonneuil & Fressoz 2016:228). Indeed, the 1IR as well as the Great Acceleration after the Second World War was made possible by the relentless exploitation of human and natural resources of the Third World by the First World, ranging from slave trade and labour in colonial times (Inikori 2002; Nunn 2008; Pomeranz 2000) to unfair trade agreements and development aid that perpetuated power relations in postcolonial times (Doyle 1986; Steinmetz 2014).

Importantly, this issue of geohistorical justice confronts all stakeholders in climate change and the 4IR with the question of 'intergenerational responsibility' (Spinner-Halev 2012; Thompson 2002). As Hannah Arendt (2003:147) observed, 'There is such a thing as responsibility for things one has not done; one can be held liable for them. But there is no such thing as being or feeling guilty for things that happened without oneself actively participating in them.' This is because descendants of a perpetrator group, though not guilty of past violence that their predecessors committed, still inherit the benefits of past violence, such as economic gains accrued through colonialism. Geohistorical injustice is therefore 'enduring' (Spinner-Halev 2007) in the sense of remaining unaddressed as '[m]ost former colonial powers have not even begun to come to terms, in any sort of meaningful way, with their imperial pasts – frequently refusing to compensate even surviving victims of terrible and obvious wrongdoing' (Butt 2015:183). Moreover, geohistorical injustice is 'structural' (Young 2011) in the sense that the systemic factors that historically undergirded colonialism, such as racism and power asymmetry, continue to be reproduced both domestically and internationally today. In other words, if '[t]he global risk of climate change is a kind of compulsive, collective memory – in the sense that past decisions and mistakes are contained in what we find ourselves exposed to' (Beck 2016:36), past mistakes that humans committed against each other must be remembered and redressed along with those they committed against Earth.[2]

It is therefore imperative for IHEs to remind all stakeholders in climate change and the 4IR of the issue of geohistorical justice so as to avoid the premature unification of multiple universes that will risk downplaying inequalities and conflicts within humanity, both past and present. In particular, the question of intergenerational responsibility can help prevent the doubling of geohistorical injustice that would entail permitting the First World, especially former colonial powers, to blame the Third World for the

2 Here, the emerging discussion of 'pluriversal dialogue' in the field of decolonial studies (Dunford 2017) can help foreground this *human* aspect of geohistorical justice along with the geological one.

latter's growing CO_2 emissions while refusing their own responsibility for having disproportionately contributed to climate change.

In this regard, I suggest that the HE debate on the 4IR – and, more generally, the worldwide debate on the 4IR – should focus on Africa, the continent that has suffered arguably the most severe and persistent form of geohistorical injustice. In fact, Africa has been rarely featured in the worldwide debate on the 4IR because the 4IR readiness among African countries is low (WEF 2018). However, precisely because this low 4IR readiness was caused by the longstanding subordination of Africa in international politics and economy, focusing on Africa can help radically reframe the debate on the 4IR around geohistorical justice, alerting stakeholders to the extensive and continuous damages that the successive waves of industrialisation have inflicted on some groups of humans inhabiting Africa and other parts of Earth that were formerly colonised. This is why this book's focus on Africa is critically important: HE practitioners in Africa are best positioned not only to transform the worldwide debate on the 4IR to engage with the issue of geohistorical justice, but also to help the HE debate on the 4IR to better articulate HE's public contribution as a temple of pluriversal diplomacy.

Conclusion and Future Directions

My proposal to champion HE's public contribution may appear too idealistic at first, given the dominant trends over the past several decades that promoted the commercialisation of research and the commodification of education (e.g., Bok 2009; Slaughter & Rhoades 2004). In many ways, these trends have been reinforced by the Covid-19 pandemic that prompted IHEs to scramble for digital transformation to adapt to the economic imperatives of the 4IR-driven post-pandemic world (Times Higher Education 2021; Mihai *et al.* 2020; The World University Rankings 2021). Nevertheless, there is also a growing worldwide movement to reclaim HE as the common good. For example, the Global University Network for Innovation (2012, 2014, 2017) has been engaging practitioners around the world to jointly contribute to urgent public issues such as sustainability, social responsibility, and social change. Moreover, the Higher Education Sustainability Initiative, jointly established by the United Nations organisations and IHEs around the world, have convened annual forums since 2016 to highlight HE's critical role in achieving sustainable development (United Nations Department of Economic and Social Affairs 2022).

Thus, this chapter aims to advance the growing worldwide movement for re-envisioning HE's public contribution in the context of the ongoing debate on the 4IR. I have specifically proposed to articulate HE's public contribution around habitable Earth as the common good. Given their longstanding role as

temples of modern societies, IHEs have an important performative role to play in reshaping the worldwide debate on the 4IR: To inform all stakeholders with the latest knowledges of the 4IR's climate impact and to facilitate pluriversal diplomacy among stakeholders with radically different positions on the compatibility between the 4IR and habitable Earth. Such reframing of the worldwide debate around climate change as the ultimate horizon of the 4IR is one of the most critical and public contributions that IHEs can offer today.

In conclusion, I would like to intimate a further line of critical inquiry that can extend HE's role in pluriversal diplomacy. While this chapter has focused on two dimensions of HE's public contribution – to produce knowledge as a common good and serve as a focal site of public debates – I suggest that there is yet another, unexplored dimension: The cultivation of what can be called 'cosmopolitan wisdom,' a fundamentally practical and deeply embodied form of being, understanding, and acting that embraces pluriversality. This is because IHEs cannot effectively facilitate pluriversal diplomacy if stakeholders lack the practical art of peaceful communication with pluriversal others, that is, those who inhabit radically different realities of climate change and the 4IR.

The first step to acquire this art of peaceful communication is to cultivate a reflective skill to become aware of one's own cognitive biases, emotional reactivity, and automatic thoughts that turn other *parties* into *enemies*, escalating disagreements into violent conflicts. To say the least, stakeholders in climate change and the 4IR need to become fully aware that '[b]y believing oneself to be a bearer of salvation, one becomes the apocalypse for others' (Latour 2017:206). Once this awareness is cultivated, the next step is to transform one's unwholesome mental habits into more wholesome ones, capable of sustaining peaceful communication with pluriversal others. Here, a process of seeking peace must already embody peace, as A.J. Muste, Mahatma Gandhi, Thich Nhat Hanh, and many other activists observed that there is no path to peace because ultimately peace is the path. Indeed, these two steps in the internal cultivation of cosmopolitan wisdom have already been suggested in the well-known and inspiring preamble of the UNESCO constitution (UNESCO 2022:4 of 101): 'Since wars begin in the minds of men, it is in the minds of men that the defences of peace must be constructed.'

To help cultivate such cosmopolitan wisdom as an essential requirement of pluriversal diplomacy, IHEs must become more inclusive towards multiple modes of learning about oneself and the world (Eaton, Hughes, & MacGregor 2017; Lin, Oxford, & Brantmeier 2013). Although IHEs have traditionally privileged scientific thinking and other intellectual modes of being, understanding, and acting in the world, an effective response to climate change requires the cultivation of the reflective skill for phenomenologically exploring the internal world – cognitive, affective, and other psychological processes that profoundly shape how one processes climate-change

knowledges and responds to other stakeholders whose positions on the compatibility between climate change and the 4IR are radically different. Thus, the third dimension of HE's public contribution can be articulated in terms of the cultivation of cosmopolitan wisdom that enables all stakeholders to participate in pluriversal diplomacy, to peacefully pursue their peaceful coexistence on, and with Earth, while much remains to be done on this third dimension.

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Chapter 9

You're on your own now! Cultivating Curiosity to Support Self-Directed Learning by Means of a Three Dimensional Questioning Strategy

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Introduction – Changing Educational Landscape

The many so-called upheavals, programmes, and plans currently being conducted all over the world, such as I4.0 (Industry 4.0 – Germany), AMP (Advanced Manufacturing Partnership) and IIoT (the industrial internet of things) (both from the USA), IdF (Industrie du Futur – France), MIC 2025 (Made in China 2025), S5.0 (Society 5.0 – Japan), and E5.0 (Education 5.0 – Zimbabwe), to name a few, are indictive of a changing landscape in the world of work. Change has always been part of our world, but the tempo of change is currently a disrupting factor, with people in all spheres of life having to adapt in order to attempt to keep up.

At the same time, resistance to change has also always been part of our world. The 'better the devil you know than the one you don't'-syndrome often kept people, societies, and industries in their comfort zones. Education in general and HE (higher education) in particular are prime examples (Caruth & Caruth 2013:12). The classroom of 2022 and the classroom of 1922 and 1822 looks disconcertingly similar, with the guiding pedagogies inside the classroom also fairly comparable. The availability and even use of new technologies did not fundamentally change classrooms or teaching and learning. Many novel approaches abound, but they have not become mainstream (Salmi 2001:105).

The reason why educational practices stayed very much the same, is because they were not total failures. All the current instances of progress, upheaval, and even disruption are driven by people coming from these kinds of classrooms, maybe even despite these kinds of classrooms because of the propensities of the learners and students themselves. The educational practices of the past and up to now did engender learning of some sorts, even of excellent sorts.

Even so, the *world of work* is now pleading for educational practices to be reimagined because they feel that educational institutions do not always deliver students that are well-prepared to meet the challenges of their respective industries (Boud & Rooney 2015:195).

These calls for change did not result in major modifications if anything at all. That is to be expected, as people are cautious in nature, and institutions even more so. What did lead to major changes in a very short spate of time, was the Covid-19 pandemic. According to Harari (2020), this worldwide event with its lockdown regulations and social distancing protocols necessitated, among other things the closure of educational institutions. The initial result was 'education as usual,' only at a distance, in what is commonly called 'emergency distance education.' Here lectures were provided in the same way as previously, only now at a distance by means of technology – lectures behind glass in the form of Zoom or Microsoft Teams lectures, PowerPoint and other presentations, and PDF files sent via e-mail or social media. It was still mainly based on traditional face-to-face pedagogical principles. Soon people realised that this is not only unsustainable because of teacher and learner burnout, but learning itself suffered from it (Bozkurt & Sharma 2020; Bozkurt, Insung, Junhong, Vladimirschi, Schuwer, Egorov, Lambert, Al-Freih, Pete, Olcott, Rodes, Aranciaga, Bali, Alvarez, Roberts, Pazurek, Raffaghelli, Panagiotou, De Coëtlogon, Shahadu, Brown, Asino, Tumwesige, Reyes, Ipenza, Ossiannilsson, Bond, Belhamel, Irvine, Sharma, Adam, Janssen, Sklyarova, Olcott, Ambrosino, Lazou, Mocquet, Mano, & Paskevicius 2020; Costello, Brown, Donlon, & Girme 2020; Hodges, Moore, Lockee, Trust, & Bond 2020; Peters, Rizvi, McCulloch, Gibbs, Gorur, Hong, Hwang, Zipin, Brennan, Robertson, Quay, Malbon, Taglietti, Barnett, Chengbing, McLaren, Apple, Papastephanou, Burbules, & Jackson 2020).

There is a plethora of important and complex reasons for this, such as access to technology issues, psychological matters, pedagogical aspects, and economic pressures, to name but a few. One aspect which lies at the heart of learning, however, is the learning behaviour of learners themselves. Learners who know how to learn effectively, are able to rise above difficult circumstances and are capable to circumvent problematic issues. For this reason, this chapter will focus on effective learning behaviour, and only on one aspect from this wide and complex field, namely *curiosity*, also called information seeking behaviour. The point of departure is the sciences of the brain and the mind.

The chapter will pursue the following train of thoughts: A complex and challenging world of work calls for effective learning in order to cope with the challenges. Effective learning is supported and enhanced by curiosity. Even though curiosity is difficult to define, its benefits are substantial and worthy to pursue. Curiosity originates in the brain, making it a universal human trait,

and as such needs not to be taught because all humans are inherently curious. What is required, is that it needs to be elicited by the way we teach, where we create the space to embrace ambiguity in the world and in the workplace. Even though it is difficult to define the term precisely, the working of curiosity can be described as being exploitative, in the sense of pursuing specific goals; explorative, in the sense of pursuing general goals; and u-shaped, in the sense of functioning best when it is not too hard, not too easy, but within reach, having to stretch in order to reach the set goal. A crucial aspect of curiosity is the ability to ask relevant and good questions. Focusing on entrepreneurship and some entrepreneurs, the importance of good questions is briefly discussed, ending with a suggestion to structure the art of asking questions in order to make sure we teach learners to ask good questions, thereby preparing them for the world of work as envisaged by the 4IR (Fourth Industrial Revolution) and the other descriptions of our complex world.

The Complex and Challenging World of Work

Knowledge is expanding exponentially, making it all the more difficult to master what there is to know in a discipline. According to Eric Schmidt, the CEO of Alphabet-Google, currently more information is created and been made available every two days than has been from the beginning of humankind up to 2002 (for a discussion and correction of Schmidt's statement, cf. Moore 2011). Technological and other developments are standing on the shoulders of previous developments, creating the progress that is taking place in leaps and bounds as described as, for instance the 4IR. The implications thereof is that it is challenging, to say the least, to master any field of knowledge. Learners cannot stand on the shoulders of giants in terms of mastery. Each one of them has to walk the path from not knowing to knowing, with new knowledge being merely copied into one's mind. In the quest for mastery, each learner has to master the art of mastery, and each learner has to find motivation to want to learn, and the passion to be curious about what they have to learn. These strategies and habits are seldom taught. Instead, content that has to be learnt, is taught, while the how and the why and the whereto is not often explicitly modelled or formally taught. Whether a learner develops the passion for learning, the motivation to learn, or the curiosity to seek the necessary information, is often left to the luck of the draw. Some develop it, but many despise or dislike learning and try to get away with learning the bare minimum of what is prescribed to them (Ackoff & Greenberg 2008).

The complexity of every discipline and field of work, linked with the easy access to and availability of information, calls for effective teaching and learning. Learners in all levels of teaching and training, from young to old, need to be able to master masses of work as part of a lifelong endeavour.

Learning never stops. They therefore not only have to know *how* to learn, they also have to *want* to learn – be curious, as it were, as an intrinsic motivation.

Linked to this is the sheer volume of what has to be learned. It is challenging to master a single field of expertise aimed at a specific vocation, which has been the focus of most teaching and training at institutions of learning up until now. What is changing, is that the complexity and interwovenness of realities call for people who are interdisciplinary informed. They have to be specialists in a primary field, even more than one, but also be generalists and knowledgeable in adjacent and even remote fields in order to be able to meet the demands of a complex world of work. Added to this is the fact that much of what needs to be mastered, do not exist as of yet and will have to be mastered autodidactically after formal studies have ended. Just studying what is prescribed is not sufficient anymore.

The question is, Do educational institutions cater for these realities, and more importantly, do they prepare their learners and students for it? Understanding and engendering curiosity is one way of addressing these realities.

The Positive and Negative Effects of Curiosity on Learning

Volumes of research have pointed out the benefits of curiosity in terms of effective learning (cf. Kidd & Hayden 2015). It is a predictor of success, it leads to better learning and memory, deeper understanding of learnt material, higher mathematics and literacy skills, more joy on the job, more happiness, and better social skills (Loewenstein 1994:75; Litman & Spielberger 2003:75; Collins, Litman, & Spielberger 2004:1127; Kashdan 2009:59; Kang, Hsu, Krajbich, Loewenstein, McClure, Wang, & Camerer 2009:963; Gureckis & Markant 2012:464; Gruber, Gelman, & Ranganath 2014:486; Leslie 2014:21). It also helps in closing the gap between disadvantaged and privileged students, where curious students from socio-economic disadvantaged backgrounds perform as well as students from privileged circumstances (Shah, Weeks, Richards, & Kaciroti 2018:380), while cultivating curiosity has a higher beneficial effect on students from a lower socio-economic status (Shah *et al*. 2018:385). When curiosity is leading to unfocused mind-wandering, it might have a negative effect on learning. Therefore, it is important to understand what curiosity is.

Understanding the role and Function of Curiosity in the Brain

A question about curiosity is whether it is an innate or a learned behaviour. Many studies regarding curiosity have been done on non-human species, from simple organisms like the roundworm, *caenorhabditis elegans* to more complex organisms and mammals (Hughes 1997:213; Loewenstein 1994:77;

Calhoun, Chalasani, & Sharpee 2014; Kidd & Hayden 2015:449, 451). In all organisms, there is a tendency to first seek locally, then to search generally or globally. These tendencies are therefore inborn behaviours, most likely because it provides immediate satisfaction of whatever needs, but also strategic long-term preparation for need satisfaction.

Curiosity, therefore does not need to be taught. It only needs to be evoked by the way learning experiences and opportunities are structured. When activated, curiosity plays a beneficial role in learning, memory, understanding, and the depth of knowledge. Gruber *et al.* (2014), for example, describe the mechanics of curiosity in the brain, based on functional magnetic resonance imaging techniques. Their research shows that areas of the brain known to be important for learning, memory, and understanding, such as the midbrain, the nucleus accumbens and the hippocampus, and especially the functional connectivity between these regions, become activated when learners are curious. This leads to better retention not only of material that the learner wants to learn, but also material that they are incidentally exposed to while learning. Lisman and Grace (2005) describe one such functional connection, namely the Hippocampal-VA loop. When the hippocampus detects new knowledge, it activates several areas involved in learning. In the upward part of the loop, dopamine is released within the hippocampus, which enhances long-term potential and better learning.

This is of importance to know because learners who have to learn complex material in an unstructured and unpredictable context such as the 4IR and related circumstances, will benefit from activating their curiosity while mastering what they have to.

A related aspect to the issue 'what they have to learn' is the emotional experience that learning is meaningful. Curiosity is more successfully evoked when learners see that what they do is related to real life issues, which is often the case when adult learners have to solve difficult, real-life problems, trying not to choose between existing answers, but to create answers to questions not previously posed, such as is the case in rapidly changing contexts of the current worlds of work. Research done by Gotlieb, Hyde, Immordino-Yang, & Kaufman (2016) about cultivating giftedness in STEM (Science, Technology, Engineering, and Mathematics), points to the importance of shifting education from knowledge transmission and regimented evaluation to aspects of intellectual curiosity, such as intentional reflectiveness, creative exploration, and mindful switching between task focus and imagining (Gotlieb *et al.* 2016:22).

With this being established, it is now important to enquire how curiosity functions in concrete situations, as described by researchers and practitioners.

Defining Curiosity, or at least be Aware of the Functioning Thereof

Although the worth and mostly positive effects of curiosity have been established, a precise and generally accepted definition of curiosity has still not been agreed upon. Several laudable attempts have been made, spanning over centuries (Inan 2017:1-15). What is clear from this, is that philosophers through the ages were aware of the positive effect of curiosity on mastering what is important to know for people in their contexts. In the same vein, William James (1912) describes curiosity as the desire in children to understand novel things they come across, and that this develops later in life into scientific and philosophical knowledge.

Loewenstein (1994:76, 87) postulates an influential psychological theory of how curiosity functions, called the Information Gap Theory of curiosity. According to him, people become curious when their attention becomes focused on a gap in their knowledge. This creates feelings of deprivation, which then motivate them to fill the gap by obtaining the relevant information. In this sense, curiosity is described as a powerful driving force to motivate people to choose behaviours, mostly learning behaviours, similar to other basic need-fulfilling behaviours such as hunger. This means that curiosity can be utilised to make learning more effective.

Curiosity is not a monolithic entity. Knowing the different kinds of curiosity, enables educators and learners alike to tap into specific efficacious ways of being curious. For example, Berlyne (1954, 1966, 1978, 2014) makes a distinction between types of curiosity along two dimensions, namely perceptual versus epistemic, and specific versus diversive curiosity. Perceptual curiosity is being interested in novel stimuli, but the interest wears off when someone gets used to it. Epistemic curiosity is the drive to acquire knowledge and dispel uncertainties. Specific curiosity is the drive to obtain a particular piece of information, solving a certain puzzle or answering a specific question. Diversive curiosity is a general desire to explore, for example rats that investigate the unknown parts of a maze even though they already know where the food source in the maze is to be found.

Litman and his colleagues (Litman 2005, 2009) distinguish between I-type (Interest-type) curiosity and D-type (Deprivation-type) curiosity. I-type curiosity is about positive feelings of engagement with new information. D-type curiosity is about feelings as a result of missing information from one's existing knowledge of something. This is important to know because it is easier to create uncertainty in the learning environment, namely D-type curiosity, to predict what content or stimuli will peak learners' interests (Jirout & Klahr 2012:150).

Renner (2006:305) adds a third kind of curiosity apart from epistemic and perceptual curiosity, namely emphatic or social curiosity. This kind of

curiosity stems from our interactions and relationships with people, and is therefore the drive and urge to know more about other people, what they do, think, and feel.

Linking to these characterisations of curiosity, Kidd and Hayden (2015:449-457) suggest that instead of focusing on the taxonomy and motivation of why people are curious, we should rather focus on the functioning thereof. Guided by the four questions formulated by the Dutch biologist Nikolaas Tinbergen (Tinbergen 1963:411), they researched curiosity in terms of function, evolution, mechanism, and development.

In terms of *function*, research points out that curiosity benefits learning by enhancing the encoding and retention of new material. Of particular interest is that it drives learners to want to master useful information they do not yet possess (Kang *et al.* 2009:963, 971; Pelz, Yung, & Kidd 2015).

In terms of *evolution*, they point out that information seeking behaviour is a crucial survival strategy, involving all our senses. Here we find two beneficial strategies. One is a long-term strategic benefit, when people explore ideas or information which have no apparent immediate benefit. Novel and unfamiliar ideas stimulate the brain's reward systems, driving our curiosity and regulating our exploration of the unknown. The drive is to improve knowledge in general in order to improve future choices. The other strategy is seeking an immediate short-term benefit, where people exploit ideas or information by choosing what they see as the best between known options. The drive is to immediately resolve uncertainty, even though it might preclude them from finding even better options.

In terms of *mechanism*, Kidd and Hayden (2015:453-454) point out that all forms of behaviour have their origin in the brain. Neuro-research on curiosity confirms Loewenstein's information gap theory in the sense that curiosity provokes the expectance of a reward. Further research indicates that curiosity and the curiosity state activate structures responsible for memory and learning, and even lead to better learning of things people are not interested in. Curiosity causes information to be regarded as valuable as anything else that people would dearly want.

In terms of the *development* of curiosity from childhood to adulthood (cf. Kidd & Hayden 2015:454-456), research done by, among others, Kang *et al.* (2009) and Kinney and Kagan (1976) indicates that curiosity optimises the use of cognitive resources in the sense that they focus attention on things we are moderately certain of. It prevents resources to be wasted on information that is either overly familiar or overly complex and totally unfamiliar. Learners prefer stimuli of an intermediate level of complexity, leading researchers to refer to it as U-shaped curiosity – not too easy, not too difficult, but within reach if you stretch somewhat. This is in line with the pedagogical theory of

Vygotsky about the zone of proximal development, stating that one should meet learners where they are in terms of knowledge, and invite them to develop further (Vygotsky 1997:29). Linked to this, is that children naturally structure their play and curiosity in ways that identify causal principles and structures (Gopnik, Schulz, & Schulz 2007:9).

From this cursory summary on how to define and describe curiosity, it is clear that there are differences in opinion, but there are enough known about curiosity and the working thereof to help us use it in terms of teaching and learning.

As humans, in order to survive and thrive, we want to know more about our world and environment. Ignorance creates feelings of want, while getting to know, gives rewards and pleasurable feelings. We want to know specific information about known variables in order to exploit available resources, and we also want to explore and learn about novel, unknown matters in order to broaden our horizons. Learning is adding to existing knowledge structures – not interested to add what is already in place, also not attending to matters which do not seem to fit anywhere at all, but adding what is regarded to be worthwhile stretching for to obtain and include.

Curiosity is therefore information seeking behaviour aimed at filling gaps in knowledge. We are all born with this survival ability, and it plays out in predictable ways, making use of likely sets of strategies. As such, it meets real felt needs of people, and in the process, they experience tangible rewards in their brains and body. Knowing this, makes it possible to utilise it in educational settings when pursuing teaching and learning goals.

This not only could but also should be taken into account by teaching professionals when designing courses and setting learning goals and outcomes for courses. For a long time, the prime focus in designing courses was focusing on the content that the lecturer deemed necessary to be taught, and which the learners had to master. Currently, many courses are being designed by multidisciplinary teams, considering content, context, and ways of delivery and assessment. These teams now have valuable extra strategies to make use of, which can assist learners and students to master content better, faster, and with more insight – which is important to prepare learners and students for the complex and challenging worlds of work out there.

Three aspects of curiosity merit more attention, namely exploitative curiosity, explorative curiosity, and U-shaped curiosity (Kidd & Hayden 2015:452).

Three aspects of Curiosity: Exploitative, Explorative, and U-shaped Curiosity

Exploitative curiosity is when you ask specific questions about a topic, such as what, when, where, and how to. Explorative curiosity is when you scout

the terrain of the topic wider than just getting simple answers. Here you ask questions such as, Why it is important to know this? and, How will you benefit from knowing it? Curiosity is 'U'-shaped, meaning that you will not be curious about matters that are at either end of the U – when it is too familiar ('I know that – it is boring!'), or too unfamiliar ('I am clueless about this – no use trying to understand it!'). It must be within reach, although you will have to stretch to get there, being at the bend of the 'U.'

Focusing on content and assessment, whether the content has been sufficiently mastered, was the name of the education game for centuries. On its own, it is good and necessary to focus on it because basic and available knowledge about any subject is important for expert performance. If this, however, is the be-all and end-all of education, it is insufficient to meet the challenges of our new contexts of rapid change. These contexts are characterised by posing many more unknown and unexpected questions than those whose answers could be memorised in courses. There is an anecdotal, tongue-in-the-cheek quip doing the round among scholars, stating that students have changed their ways in the recent past. Previously, it was alleged that the students came and ask if they may have the questions which were to be asked in the examination. That has changed because now they only ask for the answers to the examination questions. When everything is about content and standardised testing, the system will produce students who will look for answers to known questions. Unexpected questions will be unwelcome, and these kinds of students will be unprepared to manage uncertainty and the unknown. It is natural to be curious to get specific answers, but other natural aspects of curiosity need also be incorporated.

Explorative curiosity is about scouting the terrain wider than looking for answers to specific questions. Many studies on information seeking behaviour (curiosity) focus on primitive organisms, from roundworms in petri dishes to rats in mazes. In all of them, information seeking behaviour include exploitative curiosity such as looking for food, in other words, answers to specific demarcated questions, with explorative curiosity, namely scouting the terrain in general. The latter takes more time and energy, but it is worth the effort in cases where the food source moves.

The natural propensity to scout wider could and should be stimulated in formal learning circumstances. Just expecting learners to complete a prescribed curriculum, models the habit to look for fixed answers. Rather, as has been stated, curiosity does not need to be taught because it is an inborn survival strategy that only needs to be evoked by creating opportunities for it to be activated, and by doing this, becomes a habitual learning behaviour.

Scouting the terrain in terms of learning is self-directed learning in action, and this is the way to go in contexts of rapid change and development,

within circumstances such as the 4IR and similar, in order to prepare students for the future of work. An age-old tried-and-tested way to do this, is making use of asking questions instead of merely finding answers.

Curiosity and Asking Questions – and Entrepreneurs Asking Questions

The Socratic method – also called the elenctic method or method of Elenchus (refutation), is making use of asking and answering questions for the sake of understanding ideas and with the goal of developing dialogue and critical thinking (Oyler & Romanelli 2014:4-5 of 9; Delić & Bećirović 2016:511-514). Although this way of teaching has been around for a very long time, it is not used widely in classrooms. The reason may be that it takes more time than merely dumping content and testing the memorisation thereof. It also takes much more preparation time. There are also several challenges when using it in online distance teaching and learning. The value thereof, however, warrants attempts to not only incorporating it in teaching, but almost making it the agenda for presenting courses.

The saying 'Judge a man by his questions rather than his answers' is usually attributed to Voltaire. It is actually a version of a saying by Pierre-Marc-Gaston de Lévis (1808), 'Il est encore plus facile de juger de l'esprit d'un homme par ses questions que par ses réponses,' which can be translated with, 'It is easier to judge the mind of a man by his questions rather than his answers.' Even so, the value of giving preference to initiate information seeking behaviour by means of questions can be illustrated by the way people who are ultimately successful in not only navigating but ultimately initiating major change, use it. Being a study on its own, just one example will be provided, namely the way the most successful entrepreneur of all times, Elon Musk, is using it to understand his fields of expertise. As of October 2021, he became the wealthiest person that ever lived, surpassing Rockefeller (Warner 2021). He is therefore not only the wealthiest person in the world, but he is also the only person who started four different businesses who all reached billion US Dollar value.

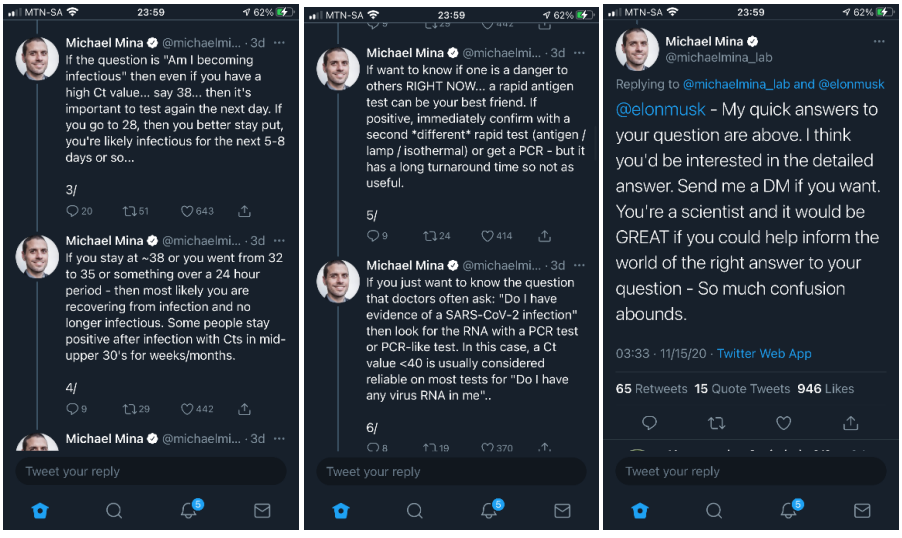
Musk already realised when he was a teenager, that 'one of the really tough things is figuring out what questions to ask. Once you figure out the question, then the answer is relatively easy' (Vance 2015:18). This way of being, caused him to eventually become the chief engineer of companies as different as SpaceX and Tesla, with all the embedded technologies in each of them.

A telling example of his habit of questioning is found in his conversation about the Covid-19 testing procedures. He had himself tested for the virus, but from the four tests that were administered on the same date at the same centre and performed by the same medical professional, two tests came back

positive while two were negative. He tweeted about it, and was lambasted on social media for sharing his experience, and accused of endangering the lives of people by casting doubt on the testing procedures and its trustworthiness. In a reaction to this, he privately contacted an expert on Covid-19 testing procedures, Michael Mina. In the discussion that ensued, Mina informed Musk about the technicalities of the procedures and how the results should be interpreted. After the discussion, Musk shared the whole discussion to all his followers, for them to share in the discussion.

What is of importance here, is not so much the outcome of the discussion, but how Musk went about when faced with a lack of knowledge in an uncertain and complex context. At some stage he wrote the following: 'In your opinion, at what Ct number for the cov2 N1 gene should a PCR test probably be regarded as positive? *If I'm asking the wrong question, what is a better question*?' (cf. Fig. 1 below).

Figure 1: Tweets between Elon Musk and Michael Mina



One goes a long way to explain the way in which his mind works and how he gets to understand a field in which he is a novice. It also explains how he managed to become an expert in the very complex industries he made a success of, as far apart from each other as space exploration, the automotive industry, green energy, and even mining and tunnelling – not to ignore brain science and artificial intelligence.

How do we teach the art of questioning in a way that will engender the skill of information seeking, both exploitative and explorative? How do we manage to do this in a way that takes into account the U-shaped character of curiosity, putting it within reach – not too near or not too far away? How do we do that in a way that is pedagogically, andragogically, and heutagogically sound, as well as feasible in a teaching and learning situation?

To my mind, this could be done by incorporating in our teaching a structured questioning strategy, which I call the 3DQS (three dimensional questioning strategy).

Curiosity as Structured Questioning: A Three Dimensional Questioning Strategy

Expecting students to ask questions about something that is new and unknown to them, is not feasible. In terms of the U-shaped character of curiosity, it is expecting them to do something that is out of their reach and will lead to dejection and self-doubt. A basic, agreed-upon foundation of knowledge needs to be provided. To do this, aspects of exploitative curiosity need to be brought into play, where specific information with intended questions and answers are provided. This should be done, however, by considering

the varying levels of expertise among the body of students. Some may have absolutely no knowledge about the discipline or that part of it which is being taught at that moment, and some might have a very good and even expert knowledge of it.

It is therefore wise to provide levels of prescribed material, with Level 1 being basic, non-negotiable material which learners need to know in order to be able to be conversant about the topic. Level 2 can be on a more advanced level, while Level 3 contains material for the budding expert. This is how, for example, Prof Tracy Tokuhama-Espinosa from the Harvard Graduate school of Education structures her *Mind, Brain, and Education* courses. In this way, she caters for both ends of the U-shaped curiosity, putting the topic within reach of the novices, but also putting it at stretch level for those who already know more or even a lot about the topic. Everyone has to stretch to reach to what is regarded by them as new but reachable knowledge and understanding.

In the discussion between Mina and Musk (cf. Fig. 1 above), the same happens. Mina provides basic information about the Covid-19 tests and testing, and then, based on Musk's questions, guides him to a better understanding of the issue at hand.

To translate this into a feasible way of teaching which will be easily memorable for learners and students, I suggest a movement-based structuring of questions that will cover all the aspects necessary to approach and eventually know and understand a new topic, field, and discipline. It is bodily movement-based, in line with the principles of embodied cognition, and as such easy to remember, freeing the mind to focus on the goal and not the strategy. Summarised, it entails looking three-dimensionally in all directions, which form the basis to eventually make a decision about the topic.

Three Dimensional Questioning Strategy

Look:

At	What is it?	Observations and analysis
Back	Where is it from?	Context and timeline
Right	How do you use it?	Use and value
Left	What else helps to understand?	Additional and collateral information
Down	How does this help *me*?	Interest, purpose, meaning
Up	Is it useful or useful enough?	Evaluation and judgement
Inside	Who am I?	Personal relevance and meaning

Then decide whether it is:

- indispensable, or
- interesting, or
- forgettable.

These sets of questions cover most, if not all aspects necessary to master a new topic or field of interest. By asking *what it is,* it focuses on observation and analysis, where basic information such as characteristics, working and constituent elements are attended to thoroughly and meticulously, with attention to detail. By asking *where it is from,* it attends to historical perspectives, such as context where it originated and functioned, as well as aspects of timelines, such as when it was first observed and what questions it attempted to answer at that time, its development, and what development or improvements might have taken place over time. Related to this are questions about *how it is used*, enquiring about the use, usefulness and value of the issue, topic, or object, thereby preventing it to be merely an abstract and disconnected idea. Embeddedness calls for questions asking *what else* could help us understand the topic, idea, or object. Additional and collateral information call for an interdisciplinary awareness, preventing tunnel vision. By asking questions about how knowing this or being able to *use this will help me*, enquires about its interest, purpose, and meaning and therefore pursues the idea of meaningful learning. By asking whether the idea, topic, of object *is useful*, it invites a critical evaluation and judgement, steering past mere acceptance of it as valid, true, or useful. Questions about *self-understanding* sensitises about subjectivity, attempting to make the learner aware of positive or negative biases towards what is being learnt. After the terrain has been thoroughly scouted in these ways, the learner is in a better position to make informed decisions about the validity and value of what has been focused on – whether to incorporate it in current knowledge structures, whether it causes current knowledge structures to be changed, or whether it can be discarded because it is outdated, skewed, or incorrect.

These questions cover the spectrum of learning, when comparing it to Bloom's knowledge taxonomy. Bloom's taxonomy (cf. Bloom, Engelhart, Furst, Hill, & Krathwohl 1956), revised in 2001 (Anderson & Krathwohl 2001) aims to describe the processes of knowledge acquisition with the goal to guide educators to set proper learning goals and objectives. According to the team led by Bloom, learning is to take place in cognitive, affective, and sensory domains. The cognitive or mental skills (knowledge) based on the domains, are described as entailing lower order thinking skills, namely knowledge, comprehension, and application, as well as higher order thinking skills namely analysis, synthesis, and evaluation (the latter two switched around in the revised taxonomy). What is interesting, is that the affective (attitude) and

the psychomotor (manual of physical skills) domains are often overlooked when the taxonomy is presented and used. For example, searches on Google Images often only refer to the six levels, as has the handout to teachers in South Africa such as the 'Be a star teacher: Bloom's Taxonomy,' provided by Macmillan Teacher Campus, guiding the CAPS (Curriculum and Assessment Policy Statement) documents.

Costa and Kallick (2008:15-41) point out habits of mind, which are a repertoire of thinking behaviours that teachers and students use to successfully manage challenges not only in the classroom, but also in everyday life. These habits cover thinking behaviours that range from the foundational mastery of learning material to an advanced understanding thereof, namely gathering data through all senses, striving for accuracy, thinking and communicating with clarity and precision, questioning and posing problems, and creating, imagining, and innovating. There are also habits necessary to guide learning behaviour, such as persisting, managing impulsivity, thinking interdependently, and remaining open to continuous learning. Contextual thinking is addressed as well, in listening with understanding and empathy and applying past knowledge to new situations. Personal meaningful learning finds a place, as in responding with wonderment and awe, taking responsible risks, and finding humour. Self-insight rounds off the set of habits, as in thinking flexibly and thinking about thinking (metacognition).

The 3D-question strategy incorporates all of the aspects mentioned in Bloom's taxonomy, namely knowledge, comprehension and application, as well as analysis, synthesis, and evaluation. It also attends to the often overlooked aspects, namely the affective or emotion-based domain as well as the psychomotor or action-based domain. The affective domain describes the involvement of the learner – from passively receiving and responding to actively participating by valuing, organising, and characterising. The 3DQS aims to involve the learner actively, and to get the learner emotionally involved in what they are busy learning by looking down and looking inside. The action-based domain is honoured by the movements and embodied cognition, by attempts to involve the person to not only learn, but also do, use, and utilise on a personal level, thereby leaving space for manual and physical skills. Similarly, the habits of mind described by Costa and Kallick are also covered by the 3DQS, from foundational mastery to personal meaningfulness.

The 3DQS could therefore be a workable, easy-to-remember-and-use strategy to guide all students, young and old, beginners and advanced, to navigate their learning terrain, ranging from initial venturing into these terrains, to an advanced mastery and elaboration thereof.

Curiosity in Higher Education

How should HE adapt to meet the requirements of the rapid changing worlds of work, with the added challenge of being in a global pandemic? According to Brink (2021), apart from the tsunami of changes within IHEs because of the Covid-19 pandemic, there is also what he calls, 'a shift in the tectonic plates of academia,' which is about the mission of HE. For a long time, everything was about academic freedom and excellence and a supply-side model of academia, based on what he calls 'curiosity-driven research.' Recently, the society 'was no longer content to hear only about what we are good at, society wants to know in addition what we are good for' (Brink 2021). Academic responsibility is necessary to augment academic freedom, and to respond to the demand side of the knowledge economy, addressing global challenges and their local variations, in what he calls 'challenge-led research.' According to him, HE has to address economic, social, cultural, and environmental challenges, seeking solutions to make society more just, inclusive, peaceful, and sustainable (Brink 2021).

Added to this is the challenge posed by the worlds of work, that the traditional three to four year residential degree is not necessarily providing the kinds of workers who cope, thrive, or excel in a rapid changing world of work. Additionally, the challenge posed by the pandemic is endangering the continued existence of both private and public educational institutions, at least in its traditional brick-and-mortar way of existence because of funding issues and dropping student numbers. Fewer local students are enrolling for reasons of health, safety, and a lack of access to funds, while political, cultural, and health issues are stemming the flow of international students and the flow of talent from east to west. Online distance and e-learning is therefore here to stay, whether for formal degree qualifications or shorter and more informal knowledge and skills-based courses, with the most important result being that students will have to be able to master this with less direct tuition and support from educators, and relying more on their own learning and mastering abilities and habits (Brink 2021).

Curiosity, or information seeking behaviour, is a natural inborn capacity for all living organisms. In humans, this need merely be given the space and opportunity to develop and thrive. Doing this in HE, entails people and a plan.

People, from educators to learners and students, need to be made aware how to harness the possibilities, power, and processes of information seeking behaviour. Many companies and industry leaders explicitly state that they are not so much interested in an applicant's formal qualifications than in their ability to master what is necessary for a specific challenge that may arise. Solid basic knowledge and understanding will always be indispensable, but which of those sets of basic knowledge and understanding will be necessary

to master at a specific point in time is what actually matters – the knowledge industry's version of the just-in-time principle. Being able to do this, calls for self-directed, lifelong learning habits and strategies for both educators and learners.

A plan to make this happen, entails institutional enabling, to start off with, but more than this, top-down intervention is a bottom-up movement where educators use the principles of structured questioning in their own research as well as in their teaching. Students at the beginning of their HE journey need to see this modelled in the way they are being taught and introduced to learning material. Learners already in the world of work will be more aware of what is needed to master, as challenges arise every day.

Curiosity, guided by structured questioning is the natural way to generate academic excellence as well as engaged responsibility in HE educators and students, responding to the challenges posed by the rapidly changing world of work.

Conclusion

The many challenges generated by the 4IR can be reduced by adding curiosity in our teaching by means of the 3DQS. Curiously – it all adds up, doesn't it?

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