Digital inequality in a developing context

A multifaceted approach

Edited by
Nobert R Jere, Gardner Mwansa, Memory Ranga, Attlee M Gamundani & Pardon B Maoneke

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AVARSITY

Peer-review declaration

The publisher (AOSIS) endorses the South African 'National Scholarly Book Publishers Forum Best Practice for Peer-Review of Scholarly Books'. The book proposal form was evaluated by our Social Sciences, Humanities, Education and Business Management editorial board. The manuscript underwent an evaluation to compare the level of originality with other published works and was subjected to rigorous two-step peer review before publication by two technical expert reviewers who did not include the volume editor and were independent of the volume editor(s), with the identities of the reviewers not revealed to the editor(s) or author(s). The reviewers were independent of the publisher, editor(s) and author(s). The publisher shared feedback on the similarity report and the reviewers' inputs with the manuscript's editor(s) or author(s) to improve the manuscript. Where the reviewers recommended revision and improvements, the editor(s) or author(s) responded adequately to such recommendations. The reviewers commented positively on the scholarly merits of the manuscript and recommended that the book be published.

Research justification

Despite significant global efforts to create a digitally transformed society, it is evident that digital inequalities persist, particularly in regions with limited access to digital services. This book aims to address these challenges by filling a critical gap in the literature, providing an in-depth examination of digital inequality across various sectors and proposing innovative solutions to bridge these gaps.

The book provides a comprehensive analysis of digital inequalities, considering the unique socio-economic, cultural and historical contexts that contribute to the digital divide. By examining these factors, and employing diverse methodologies, the book sheds light on the multifaceted nature of digital inequality and the diverse experiences of different communities, including:

1. *Historical and socio-economic context*: The book delves into the historical and socio-economic factors that have shaped digital access and usage in different regions. It explores how past policies, economic disparities and social structures have contributed to the current state of digital inequality. Understanding these roots is crucial for developing targeted solutions that address the underlying causes of the digital divide.
2. *Comprehensive sectoral analysis*: A detailed sectoral analysis is provided, focusing on key areas such as education, health care, agriculture and government services. This analysis highlights how digital inequalities manifest differently across these sectors, affecting the quality of service delivery and access to opportunities. The book discusses the specific challenges and potential solutions within each sector, offering a holistic view of the digital landscape.
3. *Focus on higher education*: The book emphasises the importance of higher education in addressing digital inequalities. It explores the role of educational institutions in bridging the digital divide, particularly in terms of providing access to digital tools, resources and learning opportunities. The book also discusses the challenges faced by students and educators in less connected regions and proposes strategies to enhance digital inclusion in higher education.
4. *Inclusivity and diversity of perspectives*: The book is committed to inclusivity and diversity, incorporating perspectives from various stakeholders, including those from marginalised communities, policymakers and service providers. By presenting a wide range of voices and experiences, the book offers a comprehensive understanding of digital inequality and the different ways it can be addressed.
5. *Impact of the coronavirus disease 2019 (COVID-19)*: The COVID-19 pandemic has exacerbated existing digital inequalities, making the need for urgent action even more pressing. The book examines the impact of the pandemic on digital access and usage, particularly in sectors like education and health care. It also discusses the lessons learned during this period and how they can inform future efforts to close the digital divide.
6. *Assistive technologies for students with disabilities*: The book highlights the role of assistive technologies in promoting digital inclusion for students with disabilities. It explores the challenges these students face in accessing digital services and how assistive technologies can help overcome these barriers. The book also discusses the importance of designing inclusive digital solutions that cater to the needs of all users.

7. *Policy recommendations and solutions*: The book proposes a range of policy recommendations and solutions to address digital inequality. These recommendations are based on the comprehensive analysis provided in the earlier sections and are designed to be practical, sustainable and adaptable to different contexts. The book emphasises the need for collaborative efforts between governments, private sector actors and civil society to implement these solutions effectively.
8. *Multi-disciplinary approach*: Recognising the complexity of digital inequality, the book adopts a multidisciplinary approach, drawing on insights from various fields, including technology, education, sociology and public policy. This approach allows for a more nuanced understanding of the digital divide and the development of holistic solutions that address the issue from multiple angles.

The book outlines the stark contrasts between well-connected communities and those struggling to access and utilise digital services. It discusses the efforts of service providers to enhance digital access across critical sectors such as education, health care, agriculture and government services. Additionally, the book proposes key steps and sustainable, innovative solutions to close digital inequalities. As we move towards achieving the goals of Agenda 2030 and the African Agenda 2063, it is imperative to expose current inequalities and take decisive action to bridge these gaps.

The authors confirm that this book contains original content and that no part of it has been plagiarised. The target audience for the book is scholars in the fields of digital inequality and development studies broadly.

Nobert R Jere, Department of Business and Application Development, Faculty of Engineering, Built Environment and Information Technology, Walter Sisulu University, East London, South Africa.

Gardner Mwansa, Department of Networking and Information Technology Support, Faculty of Engineering, Built Environment and Information Technology, Walter Sisulu University, East London, South Africa.

Memory Ranga, Department of Business and Application Development, Faculty of Engineering, Built Environment and Information Technology, Walter Sisulu University, East London, South Africa.

Attlee M Gamundani, Department of Cyber Security, Faculty of Computing and Informatics School of Computing, Namibia University of Science and Technology, Windhoek, Namibia.

Pardon B Maoneke, Department of Computing and Mathematical Sciences, Faculty of Agriculture and Natural Resources, University of Mpumalanga, Mbombela, South Africa.

Contents

Abbreviations and acronyms, figures and tables appearing in the text and notes

List of abbreviations and acronyms

4IR	Fourth Industrial Revolution
ACM	Association for Computing Machinery
ADM	Amathole District Municipality
ADP	Academic Development Programme
ADSL	asynchronous digital subscriber line
AI	artificial intelligence
AIoT	artificial intelligence of things
AIS	automated irrigation systems
AR	augmented reality
ARC	Agricultural Research Council
AT	assistive technology
AU	African Union
AWS	Amazon Web Services
BL	blended learning
BPO	business process outsourcing
BTC	Botswana Telecommunications Corporation
BUSE	Bindura University of Science Education
BWP	Botswana Pula
CANRAD	Centre for the Advancement of Non-Racialism and Democracy
CASP	Critical Appraisal Skills Programme
CCNA	Cisco Certified Network Associate
CCPF	Chipatala cha pa Foni
CCTV	closed circuit television
CEH	Certificate in Ethical Hacking
CISA	Certified Information Systems Auditor
COVID-19	coronavirus disease 2019
CPUT	Cape Peninsula University of Technology
CRAN	Communications Regulatory Authority of Namibia

CSIR	South African Council for Scientific and Industrial Research
DAISY	Digital Accessible Information System
DBE	Department of Basic Education
DCDT	Department of Communications and Digital Technologies
DHET	Department of Higher Education and Training
DOC	Department of Communications
DPT	Department of Posts and Telecommunications
DSS	decision support systems
DSPs	digital service providers
DTPS	Department of Telecommunications and Postal Services
EASSy	East Africa Submarine Cable System
ECA	*Electronic Communications Act*
ECTA	*Electronic Communications Transactions Act*
EDHE	Entrepreneurship Development in Higher Education
EHRMSs	electronic health records management systems
EHRs	electronic health records
ELAAD	Emerging Leaders in Australia-Africa Diplomacy
ERIC	Education Resources Information Centre
FAO	Food and Agriculture Organisation
FOLE	Foundation for Ontological Leadership Education
FTENs	first time entrants
FTTH	fibre-to-the-home
GEPF	Government Employees Pension Fund
GETAMEL	general extended technology acceptance model for e-learning
GIS	geographic information systems
HAIs	historically advantaged institutions
HBU	historically black university
HBUs	historically black universities
HCI	human-computer interaction
HDIs	historically disadvantaged institutions
HE	higher education
HEIs	higher education institutions
HELTASA	Higher Education Learning and Teaching Association of Southern Africa
HERDSA	Higher Education Research and Development Society of Australasia
HISs	health information systems

HWUs	historically white universities
ICASA	Independent Communications Authority of South Africa
ICT	information and communication technology
ICTs	information and communication technologies
ICT4AD	information and communication technology for accelerated development
ICT4D	information and communication technology for development
IEEE	Institute of Electrical and Electronics Engineers
IFIP	International Federation for Information Processing
IITPSA	Institute of Information Technology Professionals South Africa
IJFC	*International Journal of Fog Computing*
IoT	Internet of Things
IRDC	International Research and Development Collaboration
ISMS	information security management system
ISPs	internet service providers
IT	information technology
ITE	IT essentials
ITU	International Telecommunication Union
IUCo	Iringa University College
JAWS	Job Access With Speech
JSTOR	Journal Storage (digital library)
LED	light-emitting diode
LIMA	non-governmental organisation for rural areas
LMS	learning management system
LTE	long term evolution
MCP	Multiple Country Publication
MDGs	millennium development goals
MISs	management information systems
MOOCs	massive open online courses
MOU	memorandum of understanding
MRTEQ	Minimum Requirements for Teacher Education Qualifications
MTC	Mobile Telecommunications Company
MTN	Mobile Telephone Network
NEMISA	National Electronic Media Institute of South Africa
NGOs	non-governmental organisations

NITheCS	National Institute for Theoretical and Computational Sciences
NNCSC	Namibia National Cyber Security Competition
NPOs	non-profit organisations
NPTH	Non-Plating-Through-Hole
NRF	National Research Foundation
NSF	National Science Foundation
NSFAS	National Student Financial Aid Scheme
OECD	Organisation for Economic Cooperation and Development
PC	personal computer
POPIA	*Protection of Personal Information Act*
POTRAZ	Postal and Telecommunications Regulatory Authority of Zimbabwe
PPPs	public-private partnerships
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
PRISMA-ScR	Preferred Reporting Items for Systematic Review and Meta-Analysis extension for scoping reviews
PTC	Posts and Telecommunications Corporation
PTO	paid time off
QIAT	quality indicators for assistive technology
R&D	research and development
RMLM	Raymond Mhlaba Local Municipality
RQ	research question
SADC	Southern African Development Community
SAICA	South African Institute of Chartered Accountants
SAQA	South African Qualifications Authority
SCP	single country publication
SDGs	sustainable development goals
SMD	soil monitoring devices
SME	small and medium enterprises
SMIEEE	Senior Member of the IEEE
SMS	short message service
STARS	Student Academic Readiness Survey
STEM	Science, Technology, Engineering and Mathematics
TAM	technology adoption models
TBVC	Transkei, Bophuthatswana, Venda and Ciskei
TCAM	traditional, complementary and alternative medicine
TCK	technological content knowledge

TD	tracking devices
TEIs	teacher education institutions
TOGAF	The Open Group Architecture Framework
TPACK	technological pedagogical content knowledge
TPC	transmission control protocol
TUT	Tshwane University of Technology
TVET	Technical Vocational Education and Training
UASF	Universal Access Service Fund
UB	University of Botswana
UFH	University of Fort Hare
UHC	universal health coverage
UKAIS	UK Academy for Information Systems
UKZN	University of KwaZulu-Natal
UMP	University of Mpumalanga
UN	United Nations
UNCRPD	United Nations Convention on the Rights of People with Disabilities
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCWA	United Nations Economic and Social Development of Western Asia
Unisa	University of South Africa
UPS	uninterruptible power supply
URLs	Uniform Resource Locator
USAOs	Universal Service and Access Obligations
UWC	University of the Western Cape
VANS	value-added network
VR	virtual reality
WACS	West Africa Cable System
Wi-Fi	wireless fidelity
WIL	work-integrated learning
WiMAX	Worldwide Interoperability for Microwave Access
WOS	Web of Science
WSU	Walter Sisulu University
WWW	world wide web
ZAR	South African rand
ZICTA	Zambia Information and Communications Technology Authority

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Notes on contributors

Agyei Fosu
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: afosu@wsu.ac.za
ORCID: https://orcid.org/0000-0002-7741-1516

Agyei Fosu is a faculty member in the Department of Business Application Development at Walter Sisulu University, South Africa. Fosu's primary research focuses on the integration of information and communication technology (ICT) in agriculture, business and education. Throughout his career, he has significantly contributed to academic literature, with over 30 published research papers. He has also presented his work at prestigious international conferences, including those at Oxford University in the United Kingdom (UK) and Harvard University in the United States of America (USA). In addition to his research papers, he is the author of two books and has been invited to speak at numerous conferences. In recognition of his academic contributions, he received the Walter Sisulu University Vice-Chancellor's Merit Award in 2022, honouring him as the most productive researcher of the year.

Attlee M Gamundani
Department of Cyber Security,
Faculty of Computing and Informatics School of Computing,
Namibia University of Science and Technology,
Windhoek, Namibia
Email: agamundani@nust.na
ORCID: https://orcid.org/0000-0003-1195-366X

Attlee M Gamundani is a distinguished scholar and technologist renowned for his expertise in artificial intelligence (AI), the Internet of Things (IoT) and cybersecurity. Gamundani currently serves as an associate professor of Cybersecurity and leads the artificial intelligence of things (AIoT) and information and communication technology for development (ICT4D) Research Cluster. His career includes a significant tenure as an Information and Communication Technology for Development (ICT4D) Fellow at the United Nations University Institute in Macau, where his research focused on AI governance and ethics in the health and education sectors, contributing vital insights to the global discourse on AI. Gamundani is also known for his active involvement in community outreach and capacity-building initiatives.

As a co-founder of the Namibia National Cyber Security Competition (NNCSC), which he has been organising since 2015, he aims to bolster cybersecurity skills among young professionals. In recognition of his exceptional teaching, compelling presentations and groundbreaking research, Gamundani has received numerous accolades, including elevation to the status of senior member of the IEEE (SMIEEE). As an educator, researcher and community leader, Gamundani continues to make significant contributions to the fields of cybersecurity and AI, shaping the next generation of technologists and policymakers.

Bulelwa Mkabile-Masebe
Department of Business Management Education,
Faculty of Education,
Walter Sisulu University,
Mthatha, South Africa
Email: bmkabile@wsu.ac.za
ORCID: https://orcid.org/0000-0002-8803-8526

Bulelwa Mkabile-Masebe is a senior lecturer and a former dean of the Faculty of Education at Walter Sisulu University, South Africa. Previously, as a manager in the Directorate of Learning and Teaching, Mkabile-Masebe was responsible for academic staff development and providing academic support for students and lecturers in Learning and Teaching with Technology. She is a recipient of a Vice-Chancellor's Excellence Award (2021) because of her contribution to promoting digital learning and the use of educational technologies. Her research interests in curriculum studies, curriculum transformation, curriculum design and development and e-learning have enabled her to present research papers at national and international conferences and symposiums. She has also supervised several Honours and postgraduate students. As an emerging researcher and scholar, she has a specific interest in issues of social justice and equity in higher education. Furthermore, Mkabile-Masebe is a member of the Higher Education Learning and Teaching Association of Southern Africa (HELTASA), the Higher Education Research and Development Society of Australasia (HERDSA) and the Foundation for Ontological Leadership Education (FOLE). Her contribution to this chapter attempts to address the digital literacy gap experienced by first-year students upon entering university. In engaging with curriculum transformation discourses, academics work alongside students to navigate the higher education curriculum. Student preparedness and epistemological access depend on the context students bring with them and the extent to which higher education is prepared to meet their needs.

Courage Matobobo
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: cmatobobo@wsu.ac.za
ORCID: https://orcid.org/0000-0002-7125-5989

Courage Matobobo holds a PhD from the University of South Africa. Matobobo is a lecturer in the Department of Business and Application Development at Walter Sisulu University, where he teaches information and communication technology (ICT) modules. He has over 13 years of experience in lecturing, having taught at various institutions before joining Walter Sisulu University. He has presented his research at local and international conferences and supervises postgraduate students in the field of ICT. Matobobo's research has been published in book chapters and accredited journals, and his interests span social media, ICT4D, data mining, system dynamics and information systems. He is a member of the Institute of Information Technology Professionals South Africa (IITPSA) and the UK Academy for Information Systems (UKAIS).

David T Risinamhodzi
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: drisinamodzi@wsu.ac.za
ORCID: https://orcid.org/0000-0003-4576-7873

David T Risinamhodzi is a PhD candidate at the University of Johannesburg, South Africa. Risinamhodzi currently serves as a lecturer in the Department of Networking and Support at Walter Sisulu University, South Africa, where he teaches a range of ICT modules. With over nine years of academic experience, Risinamhodzi has developed a strong background in teaching and research. Before joining Walter Sisulu University, he lectured at North-West University, where he earned his Master's of Science (MSc) in Computer Science. Risinamodzi has shared his research expertise through various academic platforms, including conference proceedings, journal articles and book chapters. In addition to being an active researcher, he also serves as a reviewer for several academic journals and conferences, contributing to the quality and development of scholarly work in his field. His research interests focus on information and communication technology for development (ICT4D), cybersecurity, digital equality and inclusion, and machine learning, where he explores how technological advancements can foster equitable access and security in the digital age. Beyond academia, Risinamodzi is deeply committed to community development, focusing on initiatives that promote sustainability and digital inclusion, particularly in the context of the Fourth Industrial Revolution (4IR). His experience in ICT skills transfer and community visioning has enabled him to engage with local communities, ensuring that technological advancements benefit even the most underserved populations.

Gardner Mwansa
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: gmwansa@wsu.ac.za
ORCID: https://orcid.org/0000-0003-3827-9783

Gardner Mwansa is a senior lecturer at Walter Sisulu University in South Africa, specialising in agile methodologies, cloud computing, IoT, cybersecurity and educational technology. Mwansa's pioneering research focuses on integrating agile development with cloud environments to enhance adoption and utilisation in South Africa. His ongoing projects concentrate on IoT and investigate secure and efficient IoT deployment in resource-constrained environments. His cybersecurity research aims to develop robust frameworks that protect sensitive data in cloud infrastructures and IoT networks, addressing the unique challenges of digital security in developing regions. In educational technology, Mwansa has explored the impact of tools such as GeoGebra on improving students' mathematical skills and the effectiveness of zero-rated websites in promoting e-learning. His work on the influence of social media on mental health and cyberbullying underscores his commitment to leveraging technology to tackle pressing social issues. Mwansa is also an editorial board member at the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ).

Godwin P Dzvapatsva
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: g.dzvapatsva@uos.ac.uk
ORCID: https://orcid.org/0000-0001-5534-2647

Godwin P Dzvapatsva holds a PhD from the University of Cape Town (South Africa) and is a fellow of the Higher Education Academy (UK). Dzvapatsva is a lecturer and researcher at the University of Suffolk in the United Kingdom. Prior to joining the University of Suffolk, he taught in the Department of Information and Communication Technology at Walter Sisulu University. While working at one of the rural campuses of

Walter Sisulu University in the Eastern Cape province, he recognised the need for research focused on digital services and inequality in service provision, particularly in education.

Dzvapatsva's key research areas include sustainability, informatics and physical computing. He has worked extensively in the technical vocational sector and ICT coding boot camps and has authored three textbooks that are currently in use within the TVET sector in South Africa. Over the years, he has gained substantial experience in curriculum development and creating equitable learning environments. Additionally, he has undertaken several BPO projects in the Western Cape province.

Hlanganani S Sibanda
Department of Management,
Faculty of Management and Public Administration Sciences,
Walter Sisulu University,
Butterworth, South Africa
Email: hsibanda@wsu.ac.za
ORCID: https://orcid.org/0009-0003-9564-5919

Hlanganani S Sibanda is an accomplished academic specialising in development finance, focusing on strategies that address real-life obstacles faced by marginalised populations in developing countries. With eight years of teaching experience, Sibanda has taught modules in Economics and Econometrics. Sibanda is dedicated to fostering a supportive and technology-infused learning environment, encouraging students to engage critically with their studies and develop a lifelong passion for learning. She holds an Master's of Commerce (MCom) degree in Economics from the University of Fort Hare and is currently pursuing a PhD in Development Finance at Stellenbosch University. Her teaching background and qualifications provide her with a comprehensive understanding of development issues, their societal impacts and strategies to mitigate these negative effects through digital inclusion. Sibanda's research interests include development economics, microfinance and the use of technology in teaching. She has published articles in peer-reviewed journals, contributing to the academic discourse and practical implications of teaching with technology as well as in economics.

Isaac O Ajao
Department of Statistics,
Faculty of Science and Computer Studies,
Federal Polytechnic,
Ado-Ekiti, Nigeria
Email: softdataconsult@gmail.com
ORCID: https://orcid.org/0000-0002-3403-6082

Isaac O Ajao is a distinguished scholar and senior lecturer at the Federal Polytechnic, Ado-Ekiti, Nigeria. With a PhD in Statistics from the University of Ibadan, Ajao's academic journey is marked by a commitment to demystifying statistical theories and making data-driven insights accessible. His scholarly contributions include numerous publications in esteemed journals, such as the *Journal of Applied Sciences in Environmental Sanitation* and the *International Journal of Statistics and Probability*. His research spans diverse areas, including statistical modelling, data analysis and the application of machine learning in solving real-world problems. Ajao's dedication to education is evident in his extensive teaching experience, where he has taught a wide range of courses, including Statistical Packages, Data Management and Business Statistics. He has also supervised numerous undergraduate and postgraduate students. Beyond his academic achievements, Ajao is deeply committed to community engagement and charitable activities. He has served as a resource person for various training workshops on statistical data analysis, benefiting both researchers and students. Ajao's vision is to empower individuals and organisations through data education, fostering a culture of transparency and accountability. His leadership, scholarly contributions and commitment to community service make him a valuable asset to both the academic and broader community.

Jose Lukose
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: jlukose@wsu.ac.za
ORCID: https://orcid.org/0000-0001-5161-2152

Jose Lukose received his PhD degree from the University of Fort Hare, South Africa. Lukose is currently a senior lecturer and the head of the Department of Business and Application Development at Walter Sisulu University, South Africa. He has more than 25 years of experience in the higher education sector, occupying various positions such as Head of Department, Director of School, etc. His research interests include ICT in education and ICT for sustainable development. He has significantly contributed to the field of ICT through publications of peer-reviewed journal articles in reputed, accredited journals and presentations of scientific findings through local and international conferences. Service to the university and the broader community has been the core tenets of his professional identity. He has secured funding for various community outreach projects and coordinated their successful implementation, making significant contributions to the community. He is a professional member of the Association for Computing Machinery (ACM) and the Institute of Information Technology Professionals South Africa (IITPSA).

Memory Ranga
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: mranga@wsu.ac.za
ORCID: https://orcid.org/0000-0002-8970-4789

Memory Ranga is a senior lecturer in the Department of Business and Application Development at Walter Sisulu University, South Africa. Ranga holds a PhD in Information and Technology, specialising in IT governance. Her research focuses on IT governance and ICT for development. She is a member of the ICT for Sustainable Development Research Niche Area at Walter Sisulu University. Ranga is a certified information systems auditor, a certified change management practitioner and TOGAF (The Open Group Architecture Framework) certified. She serves as the internal editor for this book. Leveraging her proven expertise and hands-on experience in executing security governance, conducting risk assessments, ensuring compliance, performing security audits, assessing the effectiveness of controls, managing ISMS, ensuring data privacy, responding to incidents and overseeing cyber operations, Ranga successfully provides consultation for large enterprise security projects within various government departments in South Africa. In her efforts to raise awareness of cybersecurity and ICT governance, Ranga has dedicated time to sharing her experience and knowledge with the government sector and academic institutions.

Misheck Musaigwa
Department of Business Management,
College of Business and Economics,
University of Johannesburg,
Johannesburg, South Africa
Email: msaigwamish@gmail.com
ORCID: https://orcid.org/0000-0002-1474-5949

Misheck Musaigwa is a postdoctoral research fellow at the University of Johannesburg, South Africa. Specialising in digital transformation, Musaigwa is at the forefront of research that explores the intersections of technology, management and industry innovation. His work particularly focuses on the implications and applications of Industry 4.0. In addition to his research, Musaigwa is deeply committed to academic responsibilities, including teaching and mentoring postgraduate students. This role enables him to share his extensive expertise and cultivate the research skills of the next generation of scholars, significantly enhancing their academic and professional trajectories. Musaigwa holds a PhD in Management from the University of KwaZulu-Natal, where he developed a profound understanding of digital transformation processes within industries.

Nobert R Jere
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: nobert43@gmail.com
ORCID: https://orcid.org/0000-0001-8966-2753

Nobert R Jere is a Pan-Africanist who holds a PhD in Computer Science from the University of Fort Hare, South Africa, where he serves as an associate professor. Jere is the chief editor of this book and initiated the project while at Walter Sisulu University. He has engaged and gathered a team of researchers interested in digital transformation within the African continent to contribute different chapters to this book. He is committed to implementing digital solutions that can enable African society to flourish, firmly believing that Africa is able and capable. His research centres on sustainable emerging technologies, including machine learning, information and communication technologies (ICTs), digital transformation, open data and human-computer interaction (HCI). At various stages, he served as the chair of the ICT for Sustainable Development Research Niche Area at Walter Sisulu University. He has published numerous articles in accredited journals and peer-reviewed conference proceedings, supervising over 20 postgraduate students at the PhD and MA levels. At the time of writing this book, he is a South African National Research Foundation (NRF) Y2-rated researcher. In terms of professional qualifications, Jere is a certified ISO 27001:2013 Internal Auditor, an ISO 20000-1:2018 Lead Auditor, and is TOGAF certified. He collaborates with communities, industry and researchers on various digital projects aimed at empowering and capacitating citizens. Jere has organised and chaired international and regional conferences that attract multidisciplinary researchers in the fields of ICT and HCI. He is also a peer reviewer for accredited conferences and journals and has developed a computing curriculum that is African-centric and responsive to current regional challenges.

Nomputumo L Ngesimani
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: nngesimani@wsu.ac.za
ORCID: https://orcid.org/0000-0002-8385-1243

Nomputumo L Ngesimani holds an MA degree in Information Technology from CPUT and a Postgraduate Diploma (PgDip) in Information and Communication Technology (ICT) from the University of the Western Cape (UWC), South Africa, specialising in software development. At the time of writing this book, Ngesimani was a PhD candidate at the Cape Peninsula University of Technology in South Africa. Additionally, she is a lecturer in the Department of Business and Application Development at Walter Sisulu University, South Africa. Before joining WSU, she taught at Rosebank College in the Department of ICT in Cape Town. Alongside her university experience, she worked as an analyst programmer at Old Mutual in Cape Town for several years. Ngesimani is also a member of the curriculum development committee at Walter Sisulu University. Her key research areas include digital technology, informatics, information systems, ICT in education and ICT4D.

Nosipho C Mavuso
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: nmavuso@wsu.ac.za
ORCID: https://orcid.org/0000-0002-5602-8008

Nosipho C Mavuso is an academic at Walter Sisulu University, South Africa, in Business and Application Development. Mavuso currently holds an academic position in the Department of Business and Application Development. She was at the time of this book's writing pursuing her PhD in Information Technology at Nelson Mandela University, with a focus on developing an artificial intelligence-based career choice framework for undergraduate students. Mavuso's expertise in ICT has enabled her to contribute significantly to research in big data analytics, technology-driven knowledge creation, education recommender systems and ICTs for community development. Her research has been published in accredited journals and presented at both local and international conferences. Mavuso is dedicated to applying her research findings in practical contexts and collaborating with various stakeholders, organisations and communities. Her research projects consistently demonstrate her commitment to academic excellence and innovation. In addition to her research endeavours, Mavuso is actively engaged in teaching and mentoring, particularly in the domains of HCI and general ICT career development. She extends her educational efforts by organising workshops and webinars addressing social challenges faced by young women in society, especially in the ICT field. Mavuso is motivated by a desire to empower those around her, create opportunities for emerging female researchers and expand the boundaries of the ICT field. Her primary objective is to bridge theoretical knowledge with practical applications, influencing both academic discourse and societal outcomes.

Ntsika Dyantyi
Department of Business Management Education,
Faculty of Education, Walter Sisulu University,
Mthatha, South Africa
Email: ntdyantyi@wsu.ac.za
ORCID: https://orcid.org/0009-0009-7530-3421

Ntsika Dyantyi is a PhD candidate and lecturer in the Faculty of Education at Walter Sisulu University, South Africa. Dyantyi's expertise lies in educational management and leadership, decolonisation and educational technology, particularly in higher education and secondary school settings. He actively engages in international research conferences and holds memberships in key university committees, including the Faculty Board, Faculty Learning and Teaching Committee, Curriculum Transformation Committee, and Research and Higher Degrees Committee. Additionally, Dyantyi is a member of the Higher Education Learning and Teaching Association of Southern Africa (HELTASA) and the Entrepreneurship Development in Higher Education (EDHE) community of practice, where he contributes to initiatives promoting entrepreneurship development in higher education.

Obert Matarirano
Department of Business Management and Economics,
Faculty of Economic and Financial Sciences,
Walter Sisulu University,
Mthatha, South Africa
Email: omatarirano@wsu.ac.za
ORCID: https://orcid.org/0000-0001-5127-1028

Obert Matarirano is a senior lecturer at Walter Sisulu University, South Africa, in the Department of Business Management and Economics. Matarirano has been facilitating student learning at the university for over 16 years, bringing a wealth of experience and passion for higher education. With a Doctor of Commerce (DCom) in Business Management and a NRF rating, Matarirano is recognised for his contributions to academia and research. Since 2018, Matarirano has been actively engaged in technology-related research, with a particular focus on technology adoption in higher education. His work critically examines how students and academic staff integrate digital tools into their academic practices, exploring both the opportunities and challenges presented by the rapid evolution of educational technologies. His research seeks to deepen understanding of the technological impacts on learning and teaching in higher education institutions, providing valuable insights that inform strategies to improve educational outcomes. In addition to his research on technology, Matarirano is committed to enhancing the academic experience for his students, using innovative teaching methods and promoting the use of digital tools to foster active learning. His work aims to bridge the gap between traditional educational models and the future of technology-driven teaching and learning environments. Through his research and teaching, Matarirano continues to contribute to the development of higher education in South Africa, inspiring both students and fellow academics to embrace the transformative potential of technology.

Obrain T Murire
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
Buffalo City, South Africa
Email: omurire@wsu.ac.za
ORCID: https://orcid.org/0000-0003-3133-8744

Obrain T Murire is a senior lecturer in the Department of Networking and Information Technology Support at Walter Sisulu University , South Africa, and a distinguished academic leader. Murire holds an honours degree, an MA degree and a PhD in Information Systems, as well as a postgraduate diploma (PGDip) in Higher Education, all from Fort Hare University. His research expertise spans several critical areas, including the 4IR, information security, emerging technologies in higher education and youth employability. Murire has made significant contributions to both local and international academic discourse through numerous journal publications, peer-reviewed conference proceedings and book chapters. His research is notable for its practical relevance, particularly in leveraging emerging technologies to improve educational outcomes and job prospects for young people. His work on the 4IR reflects his commitment to exploring how digital advancements are reshaping industries and employment landscapes, especially in developing countries.

Beyond his research, Murire plays a key role in academic mentorship, supervising both master's and honours students and collaborating with colleagues on various research projects. His leadership as the research chairperson of his department has been instrumental in advancing the department's research agenda and fostering an environment of scholarly collaboration and innovation. Outside the university, he is actively involved in community initiatives, contributing to research-driven solutions that address local challenges. His community work has led to several journal publications, further solidifying his reputation as a scholar dedicated to bridging the gap between academia and real-world applications.

Olukayode Oki
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: ooki@wsu.ac.za
ORCID: https://orcid.org/0000-0002-6887-9782

Olukayode Oki received an MSc and PhD in Computer Science from the University of Zululand, South Africa, in 2014 and 2019, respectively. Oki is a senior lecturer in the Department of Networking and IT Support at Walter

Sisulu University, South Africa. He has authored more than 50 articles in local and international journals, as well as peer-reviewed conference proceedings and book chapters. His research interests include biologically inspired computation, information and communication technology for development (ICT4D), communication networks, the IoT, machine learning, data analytics and climate-smart agriculture. He has received several grants for research and development, as well as for attending conferences both locally and internationally. He is a South African NRF-rated researcher and a recipient of the 2022 Vice-Chancellor's Distinguished Research Award. Additionally, he is an Honorary Rosalind Member of the London Journal Press. He served as one of the TPC chairs for Institute of Electrical and Electronics Engineers (IEEE) AFRICON 2023 and has reviewed for many journals and conferences. He is also an editorial board member for the *ParadigmPlus* journal. Oki is a Microsoft Certified Professional, a Cisco Certified Network Associate and a member of the IEEE Region Eight Subsection.

Olutoyin Olaitan
Department of Applied Informatics and Mathematical Sciences,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: oolaitan@wsu.ac.za
ORCID: https://orcid.org/0000-0002-5350-4136

Olutoyin Olaitan is an academic and senior lecturer at Walter Sisulu University in East London, South Africa. Olaitan holds a DPhil in Information Systems from the University of Fort Hare, complemented by an MBA from the University of Technology in Akure, Nigeria and a PGDip in Higher Education from the University of the Witwatersrand. Olaitan's pedagogical vision emphasises nurturing students' problem-solving abilities and fostering creative thinking. Her research interests include the 4IR, emerging technologies, data governance and addressing the challenges of graduate attributes and student employability in developing economies. Olaitan has published numerous journal articles and conference papers, contributing significantly to the academic community. In addition to her academic pursuits, Olaitan is actively involved in community engagement projects, such as the Cybersafety Awareness campaign for high school learners. Olaitan also serves as the Chairperson of the Board for Guardians of Hope, a haven for abandoned and needy children and infants placed for adoption in East London, South Africa. She mentors postgraduate students and collaborates with colleagues on various research initiatives. Olaitan's dedication to academic excellence and community service has earned her several awards, including the Vice-Chancellor's Recognition Award for Technology Integration in Teaching and Learning. Her leadership roles and strategic contributions to departmental plans further underscore her commitment to advancing education and research in South Africa.

Pardon B Maoneke
Department of Computing and Mathematical Sciences,
Faculty of Agriculture and Natural Resources,
University of Mpumalanga,
Mbombela, South Africa
Email: blessings.maoneke@ump.ac.za
ORCID: https://orcid.org/0000-0002-7086-0044

Pardon B Maoneke holds a PhD in Information Systems and an MCom in Information Systems. In addition, Maoneke is a Certified Information Systems Auditor (CISA) and obtained a certificate in Ethical Hacking in 2018. Currently, he is a lecturer in ICTs at a higher education institution. Maoneke has more than eight years of experience in higher education, where he facilitates courses on computer security, programming and the IoT. His research interests centre on cybersecurity, particularly behavioural information security and information security management. Maoneke is interested in adopting behavioural science techniques to enhance end-user privacy. Additionally, he has interests in machine learning, artificial intelligence, big data and analytics, especially as they relate to cybersecurity. Furthermore, Maoneke focuses on the adoption and use of ICTs, examining the factors that inform the intent to adopt and utilise technology. In this regard, Maoneke has participated in projects that explored technology use in education and the public sector, including electronic governance. He conducts his research using qualitative methods and/or a design science research approach. With this research experience, he has written peer-reviewed papers presented at various internationally recognised conferences, as well as publications for journals and book chapters.

Prince DN Ncube
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: pncube@wsu.ac.za
ORCID: https://orcid.org/0000-0002-9262-3779

Prince DN Ncube is a dedicated PhD candidate at the University of Fort Hare, South Africa, at the time of this book's writing. Ncube's research focuses on optimising the operations and maintenance of solar photovoltaic systems, a crucial area in the context of the United Nations' sustainability goals. His work aims to enhance the efficiency and sustainability of renewable energy technologies, addressing global energy challenges. In addition to his research, Ncube serves as a lecturer in the Department of Networking and Information Technology Support at Walter Sisulu University, where he actively shapes the next generation of technology professionals. He is a firm believer in constructivist learning theory, and his teaching approach equips students with adaptable, innovative skills, preparing them for the ever-evolving technological landscape. His commitment to developing graduates who are ready to tackle today's challenges and lead in a rapidly advancing world is unwavering.

Before joining Walter Sisulu University, Ncube was a time-on-task lecturer in the Department of Computer Science at the University of Fort Hare. His extensive teaching experience across both institutions has enabled him to champion a forward-thinking, practical approach to education, emphasising innovation and real-world application. His academic work is deeply interconnected with his research, as his teaching fuels his inquiry into cutting-edge technologies and their practical impact. Ncube's research interests span multiple critical fields, including renewable energy, machine learning, cybersecurity ICT4D and the transformative potential of the metaverse. His interdisciplinary approach reflects his commitment to leveraging technology for sustainable development and societal advancement, particularly within the African context. Outside of academia, Ncube is an internationally qualified volleyball coach. His involvement in sports provides a dynamic balance to his academic career, fostering teamwork, strategy and leadership both on and off the court. His diverse roles as a scholar, educator and coach underscore his dedication to fostering innovation, personal growth and community development, positively impacting both academia and beyond.

Ricky M Ngandu
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: rngandu@wsu.ac.za
ORCID: https://orcid.org/0000-0003-4098-5070

Ricky M Ngandu is a lecturer currently based at Walter Sisulu University in South Africa. Ngandu holds a Master of Philosophy (MPhil) degree in ICT from the University of Cape Town, where his academic journey laid the foundation for his specialisation in key areas of the rapidly evolving digital landscape. Ngandu's research focuses primarily on cybersecurity, artificial intelligence (AI) and ICT4D, exploring how technological advancements can be leveraged to address societal challenges, particularly in developing regions. He has extensive experience teaching various undergraduate and graduate ICT modules and is passionate about bridging the gap between academia and industry. His efforts in preparing upcoming ICT professionals for the demands of the workplace are greatly appreciated. Beyond Ngandu's teaching responsibilities, he actively contributes to the academic community. He has published his research in several recognised international journals and presented his work at conferences related to his research niche, further establishing his reputation as a thought leader in his field. In recognition of Ngandu's expertise, he is a professional member of the Institute of Information Technology Professionals South Africa (IITPSA), an organisation dedicated to upholding professional standards in the IT industry. This designation is SAQA-registered and IFIP IP3-accredited, reflecting his commitment to maintaining high levels of competence and integrity in the ICT sector.

Sandra Makwembere
Department of Human Resources Management,
Faculty of Management and Public Administration Sciences,
Walter Sisulu University,
Butterworth, South Africa
Email: smakwembere@wsu.ac.za
ORCID: https://orcid.org/0000-0002-5372-6230

Sandra Makwembere is a senior lecturer in the Department of Human Resources Management at Walter Sisulu University, South Africa. Makwembere holds a PhD in Industrial and Economic Sociology as well as PGDips in Education and Disability Studies. Before her academic career, she spent six years working in civil society on social accountability projects across southern Africa which enhanced her expertise in public resource management and social justice. Her research focus areas include disability inclusion, technological change and public policy. Her current research emphasises the integration of ICT in higher education, particularly for marginalised communities, and she has published on the role of digital technologies in fostering inclusive learning environments. Her work aligns with contemporary issues in ICT for development by highlighting key challenges faced by persons with disabilities in accessing education. Makwembere has led different research initiatives, including projects on the inclusion of students with disabilities and the influence of non-formal entrepreneurship education for youth in disadvantaged communities. She is a peer reviewer of national and international academic journals. She also participates in professional associations in the fields of higher education, sociology and human resource management thus contributing to the advancement of knowledge and policy in these areas. In recognition of her scholarly contributions, Makwembere has been awarded the Productive Researcher Award at Walter Sisulu University for two consecutive years. Her research continues to add to the discourse on the intersection of technology, education and social equity, particularly in the Global South.

Sibulele Yawa
Directorate of Learning and Teaching,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: syawa@wsu.ac.za
ORCID: https://orcid.org/0009-0000-3404-7120

Sibulele Yawa is a tutor development coordinator in the Faculty of Engineering, Built Environment and Information Technology at Walter Sisulu University, South Africa. Yawa also serves as a part-time lecturer in the Department of Public Relations and Communications at the same university. Previously, Yawa was a writing centre coordinator at Walter Sisulu University and a lecturer at the University of Fort Hare. She is currently pursuing a PhD in English Studies and Contemporary Literature at the University of Fort Hare. In her current role, Yawa is passionate about creating dynamic learning environments that foster academic success and student engagement through innovative methods and strategies designed to meet students' needs. With a background in academic development and student support, she is committed to developing efficient, inclusive and engaging programmes that address the diverse needs of students. Her research interests include the incorporation of technologies into language and literary spaces, the use of digital tools in academic student support, particularly in tutorship and factors that affect student engagement in various support programmes. Yawa is also a member of the Higher Education Learning and Teaching Association of Southern Africa.

Sithandiwe Twetwa-Dube
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: stwetwa@wsu.ac.za
ORCID: https://orcid.org/0009-0009-4551-3604

Sithandiwe Twetwa-Dube is a full-time employee at Walter Sisulu University in South Africa. Twetwa-Dube has experience in administration in the Academic Development Programme (ADP) for the Extended Programme at the same institution, specifically in Information and Communication Technology. She holds a MA in Information Systems from the University of Fort Hare, is a qualified Cisco instructor and possesses industry-accredited certifications, including Cisco Certified Network Associate (CCNA 1 Version 7), Introduction to Networks and IT Essentials I (ITE Version 7), covering PC hardware and software. Additionally, Twetwa-Dube is a professional member of the Institute of Information Technology Professionals South Africa (IITPSA). Her involvement spans research, lecturing, administration, hackathon projects and community engagement initiatives. Furthermore, her research interests include e-government, teaching and learning pedagogies, smart agriculture, the 4IR, computer programming and IT/ICT in education.

Tanaka L Jere
Department of Social Sciences,
Faculty of Humanities,
University of KwaZulu-Natal,
Pietermaritzburg, South Africa
Email: jeret@ukzn.ac.za
ORCID: https://orcid.org/0000-0002-4825-0389

Tanaka L Jere, at the time of this book's writing, holds a honours degree in Sociology and Political Studies from the University of Namibia and an MA in Sociology from Nelson Mandela University. Jere volunteered for Youth Decide Zimbabwe Organisation as Secretary for Coordination and

Recruitment and is passionate about youth empowerment and transformation. He has also worked as a teaching assistant at Nelson Mandela University in the Department of Humanities and Social Sciences. Jere coauthored two chapters on the 4IR and Decoloniality in the book, *Higher education for public good perspectives in the new academic landscape in South Africa* (AOSIS Books, 2022) and also co-authored some chapters in *The Palgrave Handbook of Global Social Problems* (Palgrave, 2025). Jere is a correspondent who has written about various topics, including the coronavirus disease 2019 (COVID-19), Africa's indigenous systems and decoloniality, particularly in the context of African knowledge systems and education. He is also a fellow of the Emerging Leaders in Australia-Africa Diplomacy (ELAAD) programme. Currently, Jere is a contract lecturer at the University of KwaZulu-Natal in the Society and Social Change Cluster and is pursuing a PhD in Sociology at the same institution.

Thandokazi Mfikoyi
Directorate of Learning and Teaching,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa
Email: tmfikoyi@wsu.ac.za
ORCID: https://orcid.org/0000-0002-6640-090X

Thandokazi Mfikoyi is currently serving as the Acting Manager of Learning and Teaching with Technology at Walter Sisulu University, South Africa. Mfikoyi has been an integral part of the university's Directorate of Learning and Teaching, previously working as an instructional designer and as an educational technologist. She is pursuing a PhD in e-Research and Technology Enhanced Learning at Lancaster University. She holds a Master of Education (MEd) in ICT from the University of Johannesburg, a PGDip in Educational Technology from the University of Cape Town and an honours degree in Computer Science from Walter Sisulu University. Her scholarly contributions include a book chapter on student support during COVID-19. As the acting manager of learning and teaching with technology, she coordinates, steers and oversees the integration of technology in learning and teaching, pursuing the goal of a fully-fledged technology-enabled university. Digital access is a key area to consider in maintaining equity among students. One of Mfikoyi's research interests is the application of AI tools in learning, particularly in light of the robust emergence of AI and its integration into our everyday lives. It is important to raise awareness of these emerging AI tools and their potential benefits for learning and teaching. Continuous improvement in our practices requires evaluating our interventions, with collected data informing the development of improvement plans.

William T Vambe
Department of Mathematical Sciences and Computing,
Faculty of Science, Engineering and Technology,
Walter Sisulu University,
Mthatha, South Africa
Email: wvambe@wsu.ac.za; vambewilliam@gmail.com
ORCID: https://orcid.org/0000-0003-0516-1260

William T Vambe is a senior lecturer in Computer Science within the Department of Mathematical Sciences and Computing at Walter Sisulu University, South Africa. Before this, Vambe worked at the University of Fort Hare, University of Mpumalanga, Tshwane University of Technology, Belgium iTVersity Campus and the Ministry of Education and Harvest International in Zimbabwe. Vambe is an Associate Member of the National Institute for Theoretical and Computational Sciences (NITheCS), a member of the South African Information and Communication Technology Association, a member of the InSPiR2eS Research Network, an editorial review board member for the *International Journal of Fog Computing* (IJFC) and a reviewer for several international journals. He has supervised and mentored postgraduate students, published peer-reviewed papers and secured research grants. Additionally, he serves as an external examiner for several universities. Academically, Vambe holds a DPhil in Computer Science from the University of Fort Hare and was a PhD visiting fellow at the Mobile and Cloud Lab, University of Tartu, Estonia. He also holds an MA in Computer Science from the University of Fort Hare and a BSc in Computer Science from Bindura University of Science Education (BUSE). His research interests include fog computing, cloud computing, the IoT, ICT4D, data science for social impact and the 4IR. He believes that technology is useless if it does not simplify people's lives and address their challenges.

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Chapter 1

A South African perspective on the digital divide

William T Vambe
Department of Mathematical Sciences and Computing,
Faculty of Science, Engineering and Technology,
Walter Sisulu University,
Mthatha, South Africa

Tanaka L Jere
Department of Social Sciences,
Faculty of Humanities, University of KwaZulu-Natal,
Pietermaritzburg, South Africa

Nobert R Jere
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Abstract

With the emergence of new technology and other digital revolutions, technology has become the backbone of societal development and remains vital today. However, the digital divide and access to digital devices and infrastructure are a stumbling block in most communities, including South Africa, requiring interventions from governments, industry, civil societies, policymakers and the general populace. Regardless of having access to digital devices like smartphones and the Internet, users sometimes lack the necessary skills to use them.

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Moreover, coronavirus disease 2019 (COVID-19) exacerbates some pre-existing difficulties in the digital divide in most communities. This emphasises the need to address the digital divide and enhance digital access and infrastructure to assist even during pandemics, floods or other community challenges. These difficulties are exacerbated in communities dealing with development-related resource shortages because of several circumstances, including the digital divide. Digital inequality may widen social divides or open exciting new possibilities among those in the urban and rural areas as well as those who are privileged and people with low incomes, especially in the South African context where there is a high rate of inequality. Based on the statistical evidence from current literature, the digital divide continues to exist in most African communities. This calls for countries to address the Internet access gap because the Internet is a pillar in the digital world. Internet access and usage for communities ought to be guaranteed so that communities can take advantage of its offers. In this chapter, the authors argued that everyone should have what they need (equity), and barriers that prevent equality and equity should be addressed to achieve justice to the digital divide gap. This does not, however, imply that the idea has lost all meaning. Instead, it is more of a container notion that encompasses an excessive number of meanings. Furthermore, achieving digital equity necessitates developing relevant strategies, including local languages, encouraging literacy, organising institutional and community support and providing Internet access, skills and infrastructure.

Introduction

The digital divide is a significant obstacle to socio-economic progress in many world regions. In South Africa, this divide is particularly pronounced because of past inequalities and current socio-economic problems. This chapter examines the digital divide in the South African context, highlighting the leading causes of digital inequality and its impact on different sectors of society.

Over the past decade, technology has become a cornerstone for any country, playing a pivotal role in driving innovation, efficiency and connectivity (Daraojimba et al. 2023, pp. 769–792). It not only facilitates access to information, services and opportunities for all but also has the potential to foster social inclusion, a key aspect of a just society. Through digital platforms, people can engage in the economy more inclusively, participate and contribute to governance, and access education, health care and other facilities. Moreover, technology enables individuals to connect and compete with the rest of the world, regardless of location, thereby breaking down traditional barriers (Nakajima et al. 2023, pp. 16–25).

This technological integration not only enhances productivity and competitiveness but also ensures that the benefits of economic growth are more equitably distributed. As such, technology is a tool and a catalyst for building resilient, inclusive and forward-looking economies (Mehan 2023, pp. 33–40).

However, as argued by Faloye and Ajayi (2022, pp. 1–11) and as exposed by the coronavirus disease 2019 (COVID-19) pandemic, the persistent digital divide remains a significant barrier, particularly in South Africa. This issue is of paramount importance in the South African context, where the gap is even wider and concomitantly uneven between (1) the rich and the poor and (2) the *rural* people and *urban* people, resulting in societal inequalities. Therefore, there is a need to achieve *equality, equity and justice* in the digital realm, which is crucial in addressing the digital divide.

Undeniably, barriers to access to technological knowledge and skills, digital devices, the Internet and infrastructure in most South African communities continue to hinder participation and inclusion in digital citizenship. Moreover, these barriers have serious consequences, as they leave many individuals behind in the digital world (Faloye & Ajayi 2022, pp. 1734–1744). A school of thought (Masonta 2023) suggests that the situation might become even worse as exposed by the COVID-19 pandemic and with the coming of the Fourth Industrial Revolution (4IR), where everything will revolve around technology. Ofusori (2020) concluded that the pandemic deepened digital inequalities in South Africa.

Therefore, this chapter sought to give a synoptic view of the South African perspective on the digital divide, and the other chapters will detail the digital divide phenomenon in different application areas, such as education, health, agriculture and government services, to mention a few. The chapter is structured as follows: The section titled 'Methodological approach' discusses the study's methodological framework, while a general overview of the digital divide in the African context is presented in the section 'General overview of the digital divide in Africa'. Following that, the section 'Digital divide in South Africa' explains the digital divide specifically within the South African context. Section 'Efforts by South African government, private sector and non-governmental organisations' outlines the digital initiatives undertaken by the government, private sector and non-governmental organisations (NGOs). Section 'Robust government, private sector and NGOs partnerships in providing information and communication technology (ICT) resources and training to underprivileged communities' shares the perspectives of stakeholders – including social scientists, economists, educationists, technologists, Africanists and community activists – regarding the digital divide, based on the reviewed literature. The chapter concludes with a summary.

Methodological approach

The study used a systematic review approach to collect data. The systematic review was guided by searching for information on the digital divide and inequalities, mainly in South Africa. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) protocol was followed to determine the inclusion and exclusion criteria. These criteria were formulated based on the goals of the chapter. All relevant studies were identified and reviewed.

Search strategy

The search for resources was conducted using various digital libraries, which were used to search for various resources on the digital divide. The digital libraries that were used consist of Google Scholar, SCOPUS (https://www.scopus.com/) and Web of Science (WOS) (www.webofknowledge.com).

The aforementioned databases were chosen:

> [*B*]ecause of their international recognition and the standards they use to index articles. These databases also have a rich content of ICT and social science articles. After selecting the databases, the descriptors and keywords were determined, and the search equations were formed in order to get the best output; various Boolean search strings were formed. (Aruleba & Jere 2022 p. 2274)

These strings were employed to string together all the keywords searched in a structured way, and additional search terms were added where applicable. Titles and abstracts were adequate to 'remove articles that did not meet the inclusion' requirements (Aruleba & Jere 2022). Articles were projected against 'a fixed structure based on the PRISMA approach' (Aruleba & Jere 2022). After applying all the mentioned inclusion and exclusion conditions, relevant articles were selected for inclusion in this review. It is, however, 'important to note that some important studies [may] have been [unintentionally] skipped' (Aruleba & Jere 2022).

Study selection criteria and procedures

A set of inclusion and exclusion criteria was applied to the entire list of primary studies. The processes by which the inclusion and exclusion criteria were applied to the lists of primary studies are shown in this section.

Inclusion criteria

The following inclusion criteria were applied to studies on the digital divide and inequalities in ICT studies:

- Studies on the digital divide in Africa and South Africa
- The search includes keywords like digital divide, digital inequality and ICT.

Other studies, such as books and letters, were excluded that did not align with the chapter's main focus.

General overview of the digital divide in Africa

The term digital divide is a polysemous concept (Bornman 2016). Carroll-Miranda (2020, p. 1464.) posits that the digital divide is discrepancies in access to and the use of ICT. This definition seems like a broader perspective of the digital divide, which prompted Revina et al. (2020, pp. 1317–1323) to add to the definition and define the digital divide as 'the gap between those who have access and the skills to use ICT and those without such access and skills'. Correspondingly, Hidalgo et al. (2020, pp. 2–7) define the digital divide as 'variations in access to ICT, especially the Internet'. They argue that sometimes the digital divide results from a lack of motivation and low-income levels. These sentiments were also raised and supported by Ghobadi and Ghobadi (2015, pp. 330–340) and Lussier-Desrochers et al. (2017, pp. 3–4). Another perspective was given by Sewchurran (2020, pp. 38–60), who defines the digital divide as discrepancies in access to online communities that increased as a result of developments in ICT.

Faloye and Ajayi (2022) conclude that most definitions, as evidenced in this section, revolve around disparities in access and the skills required to use ICT. This notion was earlier supported by Bornman (2016), who argues that the digital divide is often understood as the difference between people with access to computers and the Internet and those without. Wilson, Thomas and Barraket (2019, pp. 102–120) had the same view as the previous researchers when they described the digital divide as 'the gap between those who have and those who do not have', which they simplified as the 'haves' and 'have nots'. According to Wilson et al. (2019, pp. 102–120), the 'haves' have access to and skills to use modern technologies, whereas the 'have nots' lack such. Faloye and Ajayi (2022) argue that such variations in definitions have a ripple effect on how societies reap the benefits of the digital era.

Anchoring our discussion on Hidalgo et al.'s (2020, pp. 2–7) viewpoint on the digital divide, access to ICT, especially the Internet and assuming that everyone who accesses the Internet has an ICT device, it can be concluded that many can be believed not being affected by the digital divide as scholars would say people have mobile phones that access the Internet. Because of the above reasoning, surely, the digital divide cannot be reduced to only access to ICT devices and the Internet, as attested during the COVID-19 pandemic.

Furthermore, the digital divide discussion has been a major topic on the scholarly and political agenda of new media development since the end of the 1990s (Van Dijk 2006). Further discussions on the digital divide drew more attention in the 21st century, during and post-COVID-19 pandemic. Many felt the impact of the digital divide because it was a lived experience when the whole world was arm-twisted and forced to do everything online when many countries declared lockdowns. The COVID-19 pandemic era required more than just access to ICT devices and the Internet, as captured by Ravina-Ripoll et al. (2024, pp. 145–149), but other things like 'technological skills'. Both digital natives (born during the digital age who have been exposed to technologies) and digital immigrants (born before this digital age but are adapting to it), as explained by Faloye and Ajayi (2022) were forced to adapt and adopt the new normal. Undeniably, the COVID-19 pandemic exposed many digital divide gaps and it made governments realise that they should have paid more practical attention to finding ways to mitigate and find solutions to implement on the ground. Despite what happened, it can be acknowledged that many African countries have ICT policies. Unfortunately, the lazy approach to implementation jeopardised the success of eradicating the digital divide gap in some African countries.

Despite Africa accounting for 14.1% of the global population, only 36% of Africans had access to broadband Internet in 2022 (World Bank 2023). Recent statistics show that there are certain advancements in the number of Internet users in Africa. However, there is a need to do more, as only about 570 million people across Africa used the Internet in 2024 (Statista 2024). Most African countries have poor rates of fixed line and Internet access (David & Grobler 2020, pp. 1394–1418). Microscopically looking at other African countries, fixed-line telecommunication access is higher in Mauritius, Libya and Egypt, whereas Internet access is lower in Algeria, Botswana and South Africa (David & Grobler 2020, pp. 1394–1418). Moreover, as of January 2024, Nigeria has over 103 million Internet users, making it one of the nations in Africa with the largest user base (Statista 2024). According to Campbell (2019), Internet usage in Africa differs by nation, with South Africa having a 40% online population and Kenya having an 83% online population.

Surprisingly, over 80% of people in developed countries have access to the Internet, which is a 40% difference from Africa. These statistics negate the assertion that Africa's digital divide is now better. Masonta (2023) argued that the digital divide is worsening as 3.7 billion people across the globe remain unconnected. This statement supports the point that it is about accessing devices and being connected. Masonta (2023) further argues that access might be better in urban communities but not in most rural communities, as exposed during the COVID-19 pandemic. Many realised they sometimes did not have Internet access, even digital devices.

It can be noted that during COVID-19, those who had access to the Internet and technology went ahead faster than those who did not have Internet and technology, who felt that they were left behind. This was also the case faced by most South Africans in provinces such as Eastern Cape, North-West and Limpopo, where there still is less digital development and use of technology, in particular computers and the Internet, when compared to Gauteng, Western Cape, Northern Cape which are far ahead, leading to regional discrepancies (Adeleke 2020).

Although Hidalgo et al. (2020, pp. 2–7) allude to access to ICT, especially the Internet, when defining the digital divide is widely used, microscopically looking and backed with lessons learnt during the COVID-19 pandemic era, this definition is incomplete when it is only limited to access to the Internet and digital technologies. In its current state, it lacks other aspects that help to explain how it is viewed from the African perspective. As such, we argue that the definition should include the barriers identified by Van Dijk and Hacker (2006), which include *mental access* (lack of elementary digital experience), skill access (a lack of digital skills), material access (lack of possession of computers and network connections) and usage access (lack of meaningful usage opportunities).

Additionally, even though many scholars do not pay much attention to language barriers (any linguistic limitation that creates confusion or prevents comprehension) when using technology as a digital divide barrier, we argue that it is also a cause of concern in rural areas. Wilson's (2019) definition of the digital divide says it 'is an inequality in access, distribution and use of information and communication technologies (ICTs) between two or more populations', which they revised in 2019 as the gap between those who have access to and skills to use modern technologies and those who do not have lack of it. Moreover, Revina et al. (2020, pp. 1317–1323) defined the digital divide as 'the gap between individuals with access and skills and those without', are closer to African reality and they do not look at equity and justice of technology.

The outcomes on accessibility constraints, including information resources on soft skills and ICTs by Afolayan and De la Harpe (2015, pp. 139–146) and Oyediran-Tidings et al. (2021, pp. 402–416) complement the discussion of technical accessibility and some of the cultural competencies and abilities required to employ the technology fully. Additionally, Ellison and Solomon (2019, pp. 223–244) state that the concept of the 'digital divide' needed to be reinterpreted in order to more accurately reflect the differences between high and low-poverty areas concerning access to, use of and reassurance of the integration of information technology. The emphasis on physical accessibility difficulties, as supported by Sparks (2013), complements the discussion of technical accessibility and some of the cultural competencies and abilities required to employ the technology fully.

Based on the above arguments, in the African context, specifically South Africa, we propose that the definition of the digital divide should be an injustice to (language, mental, skill, material and usage) access, distribution and use of ICTs or literally put as an injustice to access technological knowledge and skills, digital devices, Internet and infrastructure. The word justice in this work is adopted in the context of how it was explained by Opolentisima (2022, p. 2) when they say:

> [J]ustice is long-term equity. It looks to create equity in systems as well as individuals. Justice can take equity one step further by fixing the systems in a way that leads to long-term, sustainable, equitable access for generations to come.

Justice is the collective responsibility of a free and just society to ensure that civil and human rights are preserved and protected for everyone regardless of gender, race, ethnicity, nation of origin, sexual orientation, class, physical or mental ability and age.

■ Digital divide in South Africa

Since 1994, South Africa has gained independence and the issue of unequal access to resources, including technology, has been researched and documented (Faloye & Ajayi 2022; Makhado & Tshisikhawe 2020). Thirty years into democracy, most rural areas are not equipped with modern technology. In post-apartheid South Africa, the digital divide is still a significant issue (Faloye & Ajayi 2022; Motala & Padayachee 2018; Nyahodza & Higgs 2017, pp. 39–48). The COVID-19 pandemic further exposed the disparities in ICT access across socio-economic groups when everything went online. Students struggled to access online learning (Motala & Padayachee 2018; Vambe & Pindura 2022), workers struggled to work remotely (Mashudi et al. 2024; Matli & Ngoepe 2020) and the rest of the nation struggled to do day-to-day activities online (Massey 2021).

Guided by the works of Hamburg and Lütgen (2019) and Van Dijk (2020) and reasoned by Faloye and Ajayi (2022), the digital divide in the South African context can be understood into three major categories namely:

1. The digital access divide refers to *inequalities in terms of physical access to technology, particularly hardware and software*.
2. The digital capability divide is *concerned with usage and skills with regard to technology*.
3. The digital outcome divide *focuses on variations in the outcome once an individual has used technology*.

Furthermore, the digital access divide is associated mainly with educational and income levels (Cox, Cheng & Forbes 2018; Nyahodza & Higgs 2017), whereas the digital capability divide is associated mainly with inequalities in the skills required to utilise information technology resources (Bornman 2016; Faloye, Ndlanzi & Ajayi 2021) and digital outcome divide is associated mainly with disparities in individuals' outcomes such as academic performance and productivity, after capitalising on technology in a specific context (West 2019). The aforementioned interpretation of the digital divide echoes our earlier proposed definition of the digital divide, indicating that for the definition to be complete, it should include *access to technological knowledge and skills, digital devices, the Internet and infrastructure***.**

It can be noted that intensified research efforts centred on the digital access divide, digital capability divide and digital outcome divide have been carried out in the South African context (Bornman 2016; Faloye & Ajayi 2022) as described in this section.

Infrastructure and access

Since apartheid times and post-apartheid South Africa, there have always been disparities in access to high-speed Internet and mobile networks between urban and rural areas (Faloye & Ajayi 2022). Makhado and Tshisikhawe (2020) ascribed this to the apartheid regime and argued that it contributed to the reality of post-apartheid South Africa. Furthermore, they indicated that urban areas are equipped with modern technology, high-fibre Internet and mobile network connections compared to rural areas. This makes access in urban areas better than in rural areas. These sentiments were also shared by Bornman (2016), who pinpointed the lack of infrastructure in rural areas and undeveloped townships across South Africa.

Even though the marriage of mobile phones and modern-day Internet through the use of mobile phone boosters has helped bridge the gap between the connected and unconnected and opened new windows (Broadband Commission 2013), electricity challenges and the destruction of infrastructure by thieves are hindering progress in bridging the digital gap (Bornman 2016). Mashudi et al. (2024) argued that poor townships suffer from frequent power cuts, resulting in them not being online. Reliable electricity is the backbone of ICT usage and inconsistent power supply further exacerbates the digital divide (Bornman 2016). In this equation, rural areas and poor townships are the most affected because they often suffer from inadequate infrastructure, leading to poor connectivity.

This lack of basic technological infrastructure and access has repercussions. It affects rural communities (Faloye & Ajayi 2022), mainly schools, resulting in stigmatised stereotypes in relation to education and technology (Massey 2021). Moreover, businesses in rural areas are also affected. All these lead to social and economic inequalities (Faloye & Ajayi 2022).

One possible solution to the above-mentioned challenge is to use *Starlink technology* (https://www.starlink.com/technology), which has the largest satellite constellation and is hosted in space but can be accessed by rural communities without any challenge. Moreover, using other energy sources, such as solar energy, to address the electricity challenges in rural areas can go a long way in bridging the digital divide challenge caused by infrastructure and access.

Economic factors

One critical concern in South Africa is the affordability of data, Internet services and ICT devices for the general public, leading to a digital divide. Bornman (2016) highlighted that even though broadband prices significantly dropped since 2006, as per Nadoo and Seymor's (2012) findings, most South Africans still feel that the prices are still high compared to international standards (Ofusori 2020). Several lobby groups have also aired their displeasure with this through campaigns such as #DataMustFall (Moyo & Munoriyarwa 2021). Coronavirus disease 2019 has proved this, as many could not afford to be online, and the education sector was one sector among others hit very hard. In acknowledging this challenge, Internet service providers offered zero-rated access to other educational content (Vambe & Pindura 2022). Companies also ended up buying data for their workers so that they would be able to work from home (Mashudi et al. 2024).

Bornman (2016) added that the cost of ICT devices such as smartphones, computers and tablets is still high and unaffordable for many low-income households. Their findings show that those who own, many people use very old phones and very few have other ICT gadgets. Vambe and Pindura (2022) also found that access to ICT devices still challenges many South African students. This prompted universities and the National Student Financial Aid Scheme (NSFAS) to buy these ICTs for students because they could not afford them. This issue is also noted in many businesses and companies, where workers cannot afford these devices and companies have to buy them (Mashudi et al. 2024; Matli & Ngoepe 2020). From the above insights, it can be concluded that South Africa still has significant income inequality, which directly translates into unequal access to digital resources because people will not have money to spend on buying, be it Internet data or ICT gadgets. These sentiments were also supported by (Faloye & Ajayi 2022).

One possible solution to this predicament is for the government to partner with private sectors and NGOs to provide subsidies or financial support for low-income families to afford Internet services and devices if we are to bridge the digital divide gap.

Social factors

Researchers Bornman (2016) and Nyahodza and Higgs (2017, pp. 39–48) pinpointed that social factors influence the digital divide in South Africa, causing unequal access to and use of ICT. Makhado and Tshisikhawe (2020) and Nyahodza and Higgs (2017, pp. 39–48) attribute these social gaps between the 'rich' and the 'poor', those in 'rural areas and those in urban areas', the race groups that the 'white race' and 'black race' to apartheid. Post-independence in the democratic era, the disparities persist. Undeniably, these three are intertwined. It is a fact that the majority of the white race are wealthy and live in urban areas where there are better schools with better access to and use of ICT. Moreover, as argued earlier, load shedding does not affect these areas as they have alternative energy sources. Contrariwise, the majority of the black race stays in rural areas or undeveloped townships and is mainly poor as their wages are not enough to afford better access to and use of ICT. These social factors affect how these two races use information technology (IT). Works by Adhikari, Mathrani and Parsons (2015) and Mansfield (2017, pp. 78–160) found that whites tend to perform better compared to their black counterparts. Their findings were also supported by a survey of 10 South African universities carried out by Cox et al. (2018), which showed that many white students have Internet and computers at home compared to other races. Home access to digital resources directly enhances digital skills. Moreover, early exposure to digital resources may open opportunities in this digital era, especially with the coming of 4IR technologies.

Another social factor that has an effect on technological use and adoption, which leads to the digital divide, is cultural beliefs. Nyahodza and Higgs (2017, pp. 39–48) find that the number of women specialising in IT-related fields is declining as women shy away because of their family background beliefs, which discourages or does not support women. Bornman's (2016) work also supports the notion that family background and structure impact students, with those who come from parents who work white colour jobs, such as managers, professors and doctors, having high exposure to ICT, leading them to have better knowledge of technology.

Another social factor that might not be given much attention in the South African context is the language barrier. South Africa's linguistic diversity poses challenges, as much of the digital content and software is in English, which may not be the first language for many, resulting in affecting understanding and triggering people to resist technology, widening the digital divide gap (Gudmundsdottir 2010, pp. 84–105).

From these observations, it is important to note that in order to bridge the digital divide in South Africa, there is a need to take home situations and communities where they come from, among other situations, into consideration to a greater extent.

The digital divide can exist among various social aspects, which can influence the communities, cultures, group affiliations and social institutions like the family. Fuchs (2017) stresses the role of income inequality in affecting disparities in the digital divide. According to Marín et al. (2018), significant progress has been made in narrowing the digital divide over public access to ICT in higher education. However, Fucks (2017) indicates that the persistence of social factors such as income inequality continues to shape the digital landscape. Cornejo Müller, Wachtler and Lampert (2020) claim that existing social inequalities continue in the digital space and digital health interventions have not yet successfully reduced health inequalities. In addition, Torres et al. (2021) specify that the digital divide continues to be a challenge for universal access to education, mainly in the era of the COVID-19 pandemic. Thus, understanding and attending to these social factors is fundamental in bridging the digital divide and advancing more equitable access in South African communities. Therefore, it can be stated that the digital divide in the South African context exists in various societies and families.

Digital literacy skills gap

As argued by Nyahodza and Higgs (2017) and echoed by Makhado and Tshisikhawe (2020) and Faloye and Ajayi (2022), schools in wealthier areas are more likely to have access to digital learning tools, while those in poorer regions often lack such resources. This will create a digital literacy skills gap, with many individuals, particularly in disadvantaged communities, lacking the necessary skills to effectively use ICT, limiting their exposure to the digital world. Therefore, it should not be overlooked that educational disparities affect the digital divide.

A possible solution to this predicament is to create centres and fund organisations such as the National Electronic Media Institute of South Africa (NEMISA) (https://nemisa.co.za/), among others, that offer educational programmes and training for both students and adults to enhance digital skills. These programmes should also target disadvantaged communities lagging because of social and economic inequalities created by apartheid and remain a reality in post-apartheid South Africa.

It is a fact that addressing the digital divide is crucial for social inclusion and economic development and for ensuring equitable access to opportunities in South Africa. As such, the South African government should continue creating a conducive environment that encourages collaboration with the private sector and NGOs to pool resources and expertise in bridging the digital divide. Moreover, the South African government should keep ensuring its policies aim to reduce the digital divide and speed up implementation. It should monitor such initiatives to address the digital divide in South Africa effectively.

Efforts by the South African government, private sector and non-governmental organisations

It would be disingenuous not to acknowledge efforts by the South African government, private sector and NGOs. Several policies have been crafted, and strategies have been implemented to address the digital divide.

The South African Government has come up with policy initiatives and strategies such as:

1. Set up to eradicate poverty and ensure equality: The New Growth Plan (2010) and NDP (2013) were life and equality of opportunity for all and the Government's Nine-Point Plan to boost economic growth and create jobs identifies particular programmes to stimulate the economy, including through boosting ICT infrastructure and broadband rollout.
2. The National Integrated ICT policy white paper (www.gpwonline.co.za), which was approved in September 2016, replaced the White Papers on Telecommunications (1996) and Postal Services (1998). Laws such as the *Electronic Communications Act, no 36 of 2005* (the EC Act or the ECA) and the *Electronic Communications Transactions Act, no 25* of 2002 (the ECT Act or ECTA) were guided by the National Development Plan, which states that By 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous.

Furthermore, several strategies between the South African government and NGOs have borne some fruit in bridging the digital divide. As articulated by Lembani et al. (2020, pp. 70–84) and Faloye and Ajayi (2022), one initiative by the Department of Higher Education and Training in partnership with 'the private sector to promote the acquisition of technology skills and provide technological infrastructure as a measure to improve the standard of living, particularly in underdeveloped areas' helped a lot. A non-governmental organisation for rural areas also organised 'computer training workshops to promote digital literacy and create opportunities for residents of townships, rural areas, and informal settlements across South Africa' (Faloye & Ajayi 2022, pp. 1–11). Moreover, organisations such as the NEMISA (https://nemisa.co.za/) are also pivotal in bridging the digital divide gap supported by the government, private sector and NGOs.

Some scholars like Makalela and White (2021) and Rey-Moreno and Pather (2020) pinpoint that the digital divide challenges faced during the COVID-19 pandemic are a result of South African weak policies, a lazy approach and a lack of strategic direction in implementation. These sentiments were also shared by Gladkova, Vartanova and Ragnedda (2020) and Lembani et al. (2020, pp. 70–84) when they pinpointed that while the efforts of the government were commendable, the COVID-19 pandemic exposed a lot. The researchers concluded from their findings that much remains to be accomplished to bridge the digital divide in the country. Some points that can be extracted from the reviewed literature and lessons from what happened during the COVID-19 pandemic suggest that there is a need for the following:

1. A robust National Development Plan aims to improve ICT infrastructure and access by adopting *Starlink Technology* (https://www.starlink.com/technology) and other minded technologies. It has specific goals to enhance digital literacy and integrate ICT into education.
2. Robust initiatives and programmes such as providing free Wi-Fi in public spaces and schools, distributing tablets to students and providing subsidies or financial support for low-income families to afford Internet services and devices if we are to bridge the digital divide gap.
3. Robust government, private sector and non-governmental organisations partnerships in providing ICT resources and training to underprivileged communities.

Stakeholders' views on the digital divide

Social scientists, economists, educationists, technologists, pan-Africanists and community activists have all spoken out about the digital divide. They have highlighted the negative consequences of the digital divide and inequality and the importance of bridging it.

Researchers and policymakers have given the digital divide a lot of attention as an issue of transdisciplinary concern. Still, it continues to be an issue of importance that covers social, economic and political issues and impacts humanity and space. According to Mwim and Kritzinger (2016, pp. 1–8), the 'digital divide' may lead to a 'knowledge divide', which measures how much individuals understand about the universe, their immediate surroundings and their level of safety. A lack of such information and expertise could also affect how communities evolve. Digital technology may widen social divides or open exciting new possibilities among those in the urban and rural areas as well as those who are privileged and the poor, especially in the South African context where there is a high rate of inequalities.

Furthermore, Warschauer (2003, pp. 42–47) argues that a 'digital divide' creates a false dichotomy between individuals with and without access to computers and communications technology, which can also be used to solve problems. Hence, any attempt to introduce new technology must consider how users can use digital devices and the Internet for various purposes like development, interactions and so forth (Statista 2024). Furthermore, achieving this goal necessitates developing relevant information in various languages, including local languages, encouraging literacy and organising institutional and community support. It also involves providing Internet access, skills and infrastructure.

Furthermore, according to Reynolds et al. (2020, pp. 273–286), the dominant strategy for closing the digital divide focuses on a twofold distinction between connected Internet users and those who are not. A more sophisticated approach to the digital divide and a thorough understanding of digital inequality are fundamental to avoiding increasing inequalities because of differences in effective access provided by the Internet. Therefore, enabling digital connectivity has the potential to eliminate most potential access disparities.

According to DiMaggio and Hargittai (2004, pp. 4–2), the Internet will increase citizens' access to government and establish new democratic spots for political discourse. DiMaggio and Hargittai (2004, pp. 4–2) contend that a deeper understanding of digital inequality necessitates placing Internet access in a larger theoretical context. They concur that inequality of access is crucial because it reinforces inequality in chances for economic mobility and social participation. Van Deursen and Van Dijk (2023, pp. 1248–1270) indicate that the 'digital divide' denotes the disparity between those who have access to various ICTs and those who do not. Unfortunately, the digital divide has given rise to many misunderstandings and inspired at least some of them, implying that it may be challenging to close this gap. It can indicate absolute differences between those who are involved and those who are excluded, but changes are more often of a relative nature. The digital divide is not static.

In-depth scrutiny of the recent literature on the digital divide and inequalities, various experts' views, as summarised in Table 1.1, including the works of Chetty et al. (2018), African Union Commission (2021) and Berson, Luo and Yang (2022) reached to a conclusion that digital divide requires an agent attention. Table 1.1 presents the authors' summarised views based on the literature, which will be elaborated on in the other chapters of this book.

The summary highlights diverse considerations on the digital divide and inequality. It is important, therefore, for various experts and stakeholders to work together to bridge the digital divide and inequality so that everyone can benefit from the Internet, support and digital technologies.

In addition, developing digital skills and infrastructure both need to be prioritised to support digital transformation. Following the initial maintenance and review of digital training programmes is essential to investment in developing digital skills. As the drive for digital inclusion continues, Chirwa et al. (2023, pp. 1–19) emphasise that Africa has

TABLE 1.1: Summary of digital inequality.

Scholars	View
Social scientist	The digital divide and inequality are a major obstacle to development (Ragnedda 2019, pp. 27–44). It prevents people from accessing essential information and services, making it difficult for businesses to compete in the global economy.
Economist	The digital divide and inequality are exacerbating existing inequalities whereby the poor and marginalised are less likely to have access to the Internet and digital technologies, which further disadvantages them (Karar 2019, pp. 514–537).
Educationist	Liu (2021) specifies that the digital divide and inequality prevent students from reaching their full potential. They need access to the Internet and digital technologies to succeed in the 21st-century economy.
Technologist	The digital divide and inequality are a moral injustice. Kuiler (2024, pp. 222–241) stresses that everyone deserves access to the Internet and digital technologies, regardless of income or location.
Pan-Africanist	The digital divide and inequality threaten Africa's democracy and security (Aniche & Mike 2023, p. 285). It prevents citizens from holding their governments accountable and it makes it easier for extremist groups to spread misinformation.
Community activist	Human rights are violated by inequality and digital gaps. Everyone has the right to access information and communicate freely (Drori 2010, pp. 63–91). The digital divide and inequality deprive Africans of this right.

Source: Authors' own work.

certain repercussions. Bridging strategies like income transfers may be helpful, given that usage and availability of phones impact the digital divide. The United Nations (UN) Agenda 2030 and the African Union (AU) Agenda 2063 both serve as guides for the national development goals of African member states and many of these states have updated their national development policies to align with both agendas.

Multiple stakeholders can play various roles in developing, overseeing and sustaining such platforms. To solve digital inequalities, there is a need for proper collaboration between governments, communities, ICT experts and organisations that aim to advance technology in societies. In addition, collaboration on a global, national and personal level may help tackle the problem of creating an inclusive digital society.

■ Conclusion

The digital divide in South Africa is a multi-faceted problem influenced by historical, socio-economic and technological factors. Addressing this divide requires a comprehensive, multi-stakeholder approach. By recognising the unique challenges of different communities, more effective strategies can be formulated to promote digital inclusion and equal opportunities. In a nutshell, this chapter provides a general overview of the digital divide. The chapter provided a synopsis of the digital divide in some African countries as a broader context, even though the main focus is the South African context. The chapter provides the views of stakeholders such as social scientists, economists, educationists, technologists, Pan-Africanists and community activists regarding the digital divide and digital inequities well-connected and less-connected areas were articulated, less-connected areas were articulated as well as restricted information access and transparency. Sustainable and achievable solutions to the digital divide and digital inequality were also highlighted. Thus, the rest of the chapters give a detailed view of how the digital divide affects different sectors, such as education, industries and the health sector, among many other sectors. They present a comprehensive analysis that highlights the critical issues and propose strategies to bridge the digital divide in South Africa by looking at the following aspects:

- 'Digital inequalities in South African higher education: A multi-level students' perspective': This chapter examines digital inequalities at multiple levels in South African higher education. It looks at the impact of government policy, funding formulas and geographical locations on digital access at the macro level. At the meso level, institutional resources and teaching practices are discussed, while the micro level focuses on students' digital readiness and access disparities between rural and urban areas.
- 'Social, economic and digital inequalities among students at South African universities': This chapter examines how social stratification, gender stereotypes, cultural norms, late technology adoption and geographical location contribute to digital inequalities in higher education. It highlights the challenges faced by first-year students from disadvantaged backgrounds.
- 'Digital inequalities' impact on pre-service teachers in South African universities': The chapter explores digital inequalities in developing 21st-century skills among pre-service teachers. It discusses how these inequalities affect teachers' willingness and ability to integrate digital technologies into their teaching practice.
- 'Navigating digital inequality in African higher education: Challenges and charting a path forward': This chapter addresses digital inequalities in higher education on the African continent. It addresses infrastructural challenges, pedagogical implications and case studies on digital inequality. It also discusses new technologies and future trends.
- 'Digital divide in the agriculture sector for small-scale rural farmers in South Africa': This chapter focuses on digital inequalities affecting small-scale rural areas. It discusses technology adoption among farmers, the role of innovative technologies and the impact of digital inequality on agricultural productivity and economic growth.
- 'Addressing digital inequality in rural primary healthcare systems in sub-Saharan Africa': This chapter examines digital inequality in rural primary healthcare systems. It highlights the causes, cultural and behavioural factors and consequences of digital inequality in healthcare. It also suggests strategies for digital inclusion and future directions.

- 'Impact of digital inequality on service delivery in African higher education': This chapter examines the impact of digital inequality on service delivery in higher education. It discusses the importance of digital technologies, indicators of digital inequality and the multiple challenges that impact educational outcomes.
- 'Mitigating the unintended consequences of technology adoption in South African higher education': This chapter discusses the unintended consequences of rapid technology adoption in South African higher education, particularly during the COVID-19 pandemic. It highlights the socio-economic disparities, digital inequalities and the need for comprehensive strategies to mitigate these consequences.
- 'Role of service providers in shaping and advancing digital services in southern Africa: A case study': The chapter discusses the role of digital service providers in enabling digital services and infrastructure. It presents case studies from various parts of southern Africa and highlights the impact of telecommunications on digital inequality.
- 'Disabled students' experiences of using assistive technologies in southern African universities': This scoping review provides insights into the experiences of students with disabilities using assistive technologies in higher education. It highlights these students' challenges and successes and the importance of inclusive digital service provision.

Chapter 2

Digital inequalities in South African higher education: A multi-level students' perspective

Obert Matarirano
Department of Business Management and Economics,
Faculty of Economic and Financial Sciences,
Walter Sisulu University,
Mthatha, South Africa

Misheck Musaigwa
Department of Business Management,
College of Business and Economics,
University of Johannesburg,
Johannesburg, South Africa

Abstract

This chapter examines the pervasive digital inequalities in South African higher education from multiple levels. It explores how information and communication technologies (ICTs) are deeply integrated into modern society and their critical role in education. Using a narrative systematic literature review, the chapter highlights the challenges faced by historically disadvantaged institutions (HDIs) compared to historically advantaged institutions (HAIs), focusing on underfunding, resource allocation and infrastructural disparities. It also addresses the impact of government

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policies, funding formulas and geographical locations on digital access at the macro level. At the meso level, the chapter discusses how institutional resources, staff capabilities and instructional methods affect university technology integration. On a micro level, the authors analyse factors influencing students' digital readiness, such as social influences, self-efficacy and differential access to technology between rural and urban areas. The findings reveal that HDIs face significant challenges in technology adoption because of underfunding and a lack of infrastructure compared to HAIs. Students from rural areas and lower socio-economic backgrounds also experience greater digital access and learning barriers. The study concludes that while policy efforts are in place, substantial disparities remain, necessitating targeted interventions to bridge the digital divide and promote equitable educational opportunities for all students in South Africa.

Introduction

Chapter 1 explored digital inequity from the perspectives of various stakeholders and sectors. It discussed the challenges in access and proposed solutions in line with the digital strategies for African Agenda 2030–2063. Building on the overview of digital inequalities in South Africa, as presented in Chapter 1, this chapter looks at the specific experiences of students in higher education (HE). It examines digital inequalities from a macro (national and policy level), meso (institutional level) and micro (individual level) perspective to provide a comprehensive understanding of the challenges students face. Information and communication technologies have evolved into a critical and essential element of modern society. Aruleba, Jere and Matarirano (2022a) emphasise that technologies are deeply integrated into people's daily lives and are now irreplaceable. In education, ICTs have a profound impact on students' learning processes (Uziak et al. 2018).

Given that most university students are 'digital natives', technology has become a fundamental solution to various learning challenges (Hussein 2017). Digital technology is now popular to the extent that it is used even at pre-primary levels of education for young children (Kalogiannakis & Papadakis 2017). To remain relevant in the technology-driven global economy, higher education institutions (HEIs) need to adopt and use appropriate digital technology. Apaza-Yllachura, Paz-Valderrama and Corrales-Delgado (2019) and Liu et al. (2021) argue that HEIs in developing countries are at the early stages of adopting technology, and there is still a fundamental amount of work ahead to achieve digital transformation.

In today's HE, students are expected to utilise technology in their studies (Aruleba, Jere & Matarirano 2022b). The recent coronavirus disease 2019 (COVID-19) pandemic has shown that technology is no longer a luxury but a critical aspect of HE (Jantjies 2020). In the 21st century, it is anticipated that students will proficiently utilise ICTs regardless of their field of study (Andreu & Nussbaum 2009). Apaza-Yllachura et al. (2019) and Liu et al. (2021) argue that HEIs in developing countries are in the early stages of adopting technology. There is still a significant amount of work ahead to achieve digital transformation. In many academic institutions, traditional face-to-face (F2F) instruction has been replaced by blended learning (BL) and/or online learning (Mali & Lim 2021).

From a macro level perspective, historical disparities between historically disadvantaged institutions (HDIs) and historically advantaged institutions (HAIs) continue to persist because of underfunding and resource prioritisation (Chetty & Pather 2015; Mekoa 2018). In addition, infrastructure discrepancies between rural and urban areas further exacerbate inequalities, affecting students' access to stable network connections and technology. Moreover, government policies, funding formulas and geographical location significantly impact digital disparities at a national level. From the meso level, HDIs face resource constraints impacting their ability to provide a conducive environment for technology adoption and use. Infrastructure, financial resources, staff capabilities and institutional culture significantly affect university technology integration and readiness. Furthermore, differential instructional methods, language medium and programme structures contribute to disparities in technological exposure and utilisation among students. It was also found that at the micro level, students' digital readiness and technology adoption are influenced by multiple factors. Social influence, including the impact of lecturers' ideologies and beliefs, shapes students' attitudes towards technology. Also, technology experience and self-efficacy significantly affect students' readiness for online learning, with disparities emerging because of differential access to technology, especially between rural and urban students. This study aims to comprehensively examine the multifaceted nature of digital inequalities within HE, elucidating the interplay between macro, meso and micro-level factors and proposing actionable strategies to mitigate these disparities. Such an understanding assists in recommending actionable interventions and policies that address the structures affecting digital inequality, eventually improving digital equity and justice.

The role of digital technology in higher education

The role of ICT in HE is evident in universities where online learning is practised, and students are expected to use learning management systems (LMSs). Online learning is learning whereby access to courses and interactions in the learning process is driven by digital technology (Hodges et al. 2020) in both synchronous and asynchronous ways. The synchronous setup of the technologies enables direct interaction between students and lecturers, providing instant feedback (Gegenfurtner, Zitt & Ebner 2020). Digital technology platforms mostly used in HE include LMSs, video conferencing platforms (Rahiem 2020) and social media platforms such as WhatsApp and YouTube. While WhatsApp is a popular social media platform, its use for teaching and learning is encouraged by HEIs (Aristovnik et al. 2020).

Benefits of digital technologies

Many authors have highlighted a multitude of benefits that come with online learning in HE. Online learning helps facilitate interactions among students and learning content and provides accessibility to learning activities. Given that many students in HE are often referred to as 'digital natives', integrating technology into the learning process is both appropriate and essential (Hussein 2017). Many students appreciate the convenience of recorded lectures and classes as they can access the content whenever they have enough data, network and time. They can also play, pause, rewind and fast forward whenever needed (Matarirano et al. 2021a & Yeboah 2021a). The study by Musaigwa (2024) indicates that digital transformation is fundamental in improving internal and external efficiency, including enhancing service delivery and eliminating administrative errors. Furthermore, Musaigwa (2022) demonstrates that digital transformation reduces operating costs, improves quality and enhances customer satisfaction.

Digital inequalities

While access to technology is open to all, real access is enabled and constrained by many social contexts. Research in South African HE indicates digital inequalities, especially among university students. Challenges such as limited access to digital devices and Internet connectivity exacerbate societal inequalities (Kotecha 2009). These inequalities are further compounded in rural areas where infrastructure and network connection are significant barriers (Duma et al. 2021). Those with no devices, access to stable networks, and the inability to utilise the functions of technology are alienated from the digital bandwagon. The shift to remote learning in HE because of the COVID-19 pandemic highlighted and exacerbated existing societal inequalities between affluent and impoverished populations, as well as between rural and urban areas (Aguliera & Nightengale-Lee 2020; Firat & Bozkurt 2020), thereby expanding the digital divide among students (Krönke 2020; Shin & Hickey 2020; Williams, McIntosh & Russell 2021). These social inequalities hindered academic interactions. The differences between citizens' access to digital technologies and the environment's ability to utilise the technologies describe digital inequalities. In the HE space, these inequalities influence the adoption and use of ICTs, leading to digital inequalities. This chapter attempts to explain the digital inequalities in South African Higher Education for university students, looking at the macro, meso and micro levels.

The field of technology adoption and experiences of role players in the HE space (lecturers and students) have been heavily researched, especially with the advent of remote learning because of the COVID-19 pandemic. However, much of the research has not been conducted in the South African context. In explaining the digital inequalities and offering conditioning that could have led to the emergence of identified experiences, the social structures were viewed at the macro, meso and micro levels of social analysis (Serpa & Ferreira 2019).

This approach was selected as it brings to the fore all the players in digital inequalities as well as their interactions. Cunningham and O'Reilly (2018) argue for a need to research more on technology transfer at all levels of analysis (macro, meso and micro). Adopting such an approach means that the causes of digital inequalities are explained based on all levels of decision-making, from the national level to individual users. The approach is also recommended by Serpa and Ferreira (2019), who claim that comprehensively understanding social phenomena requires consideration of the macro, meso and micro levels and their interconnections. According to Cunningham and O'Reilly (2018), the macro level helps identify the policies and institutions that enable or constrain technology use at the national level while the meso level provides insights into how technology transfer occurs within specific institutional contexts. This approach is considered a holistic approach that addresses technical skills, socio-cultural norms, educational systems and policy frameworks (Chetty et al. 2018). Following this approach, the rest of the chapter discusses digital inequalities at these different social analysis levels.

Methodology

Research design

This chapter utilises a narrative systematic review methodology to synthesise existing research on digital inequality within South African higher education. Systematic reviews are meticulous methods for identifying, assessing and summarising the results of all relevant individual studies on a given subject. This methodology ensures a deep understanding of the literature, facilitating the identification of consistent trends and gaps in the chapter.

Literature search strategy

A number of scholarly databases, including Scopus, Web of Science and Google Scholar, were used to search for literature. The following search phrases were used: 'digital divide', 'digital inequality', 'higher education', 'South Africa' and 'students'. To combine search phrases and hone the search results, Boolean operators (AND, OR) were used. Additionally, reference lists of relevant articles were manually searched to identify further studies.

Inclusion and exclusion criteria

Certain exclusion and inclusion criteria were applied to ensure the relevance and quality of the research included in the review.

- *Inclusion criteria*: Research on the digital divide or inequality in HE, journal articles, books, chapters and conference papers subjected to peer assessment and English-language publications.
- *Exclusion criteria*: Studies not related to HE, articles, opinion pieces and non-peer-reviewed editorials and publications in languages other than English.

Data extraction and synthesis

To ensure uniformity, data extraction was carried out using a standardised form. Each study's author(s), publication year, study site, design, sample characteristics, main findings and conclusions were taken from the data. Subsequently, a narrative synthesis technique was employed to synthesise the gathered data, which involved interpreting and summarising the results from all of the included research.

Quality assessment

Using the Critical Appraisal Skills Programme (CASP) checklists, the quality of the included studies was evaluated. These checklists assess a study's methodological quality using a variety of factors, including the study design, sampling strategies, data collecting techniques and the reliability of the results. Only studies with a medium or high-quality rating were included in the final synthesis; studies with a poor-quality rating were excluded.

Data analysis

The analysis identified repeated themes and trends about digital inequality in South African higher education. The results were categorised into key topics using thematic analysis, including the influence of socio-economic position, digital literacy, access to technology and institutional support. After that, these themes were investigated at the macro, meso and micro levels to give a thorough grasp of the problem.

- *Macro-level analysis*: This level looked at how infrastructure, finance, and national and local policies affected equity and access to digital resources.
- *Meso-level analysis*: At this level, institutional practices, policies and resources in higher education institutions were examined.
- *Micro-level analysis*: This level looked at specific student experiences, such as device access, Internet availability and proficiency with digital tools.

The book chapter's goal of offering a thorough and evidence-based study of digital inequality in South African higher education aligns with the systematic review methodology. This process ensures that the chapter is firmly based on a thorough grasp of current literature by methodically finding, assessing and synthesising pertinent studies. The chapter's objective of examining digital inequality from many perspectives aligns with the organised framework provided by the thematic synthesis of results at the macro, meso and micro levels. In addition to highlighting the most important problems and knowledge gaps in the field, this strategy provides suggestions and insights for resolving digital inequality in HE.

Digital inequalities by level

Digital inequalities reported in the literature result from factors under the control of the users but also beyond their control. Lack of or unstable network connection, lack of digital devices and data, and inability to use the device and related applications are some of the causes of the inequalities in the HE sector. While the structures are discussed separately, in terms of the identified levels, it should be noted that the emergency of events and experiences does not result from each factor separately but from the complex interplay of mechanisms where these factors emanate. It is the combined interplay of these multitude of factors that lead to digital inequalities.

Macro level

The macro level provides enablers and constraints to technology adoption and use at national or regional levels (Cunningham & O'Reilly 2018). It describes the highest level of social analysis, focusing on social structures beyond the control of individuals (Serpa & Ferreira 2019) and includes policies and social institutions that enable or constrain the transfer of knowledge between different actors (Cunningham & O'Reilly 2018; Serpa & Ferreira 2019). At the macro level, the national government provides an enabling environment for technology adoption and use. Many students have reported negative experiences with the use of technology, especially during remote learning periods, because of the inability to fully engage in learning activities (Matarirano et al. 2021a).

The South African higher education system is distinguished by the presence of two categories of institutions: HDIs and HAIs (Department of Higher Education and Training [DHET] 2014). This categorisation is a result of historical structures that were meant to perpetuate social inequalities by creating policies that oppress the black majority. 'Historically disadvantaged institutions' refer to a cohort of universities that predominantly served the black population during the apartheid era (Nyoni 2020). The HE system was segregated along racial lines: the 'Black' universities, which were meant for the black majority and catered for Africans, mixed race and Indians and 'White' universities, which were created for the ruling 'White' minority (DHET 2014). Resources for universities designated for the black population were not prioritised, resulting in significant resource constraints for these institutions (Chetty & Pather 2015; Mekoa 2018). The institutions meant to serve the 'blacks' were underfunded and received less financial support than the 'white' institutions. This distinction has played a major role in the current disparities and inequalities within the South African Higher Education sector. The term 'historically disadvantaged institutions' (HDIs) was introduced in the post-apartheid era to recognise the historical injustices in HE and to address the significant disparities between black and white universities. This designation aims to support the development of public universities classified as HDIs (Africa & Mutizwa-Mangiza 2017). Eight universities have been designated as HDIs (DHET 2014). These universities primarily serve black students, many of whom come from socio-economically disadvantaged backgrounds and have faced inequalities even at the level of basic education (Gqokonqana et al. 2021). Most HDIs exhibit underdevelopment and financial instability relative to HAIs. This underdevelopment has hindered HDIs from effectively achieving their missions and establishing themselves as dynamic academic entities (DHET 2018). Conversely, HAIs have reaped the benefits of supportive policies and advantageous resource allocation, which confer upon them a competitive edge (Nyoni 2020).

Despite efforts to support the development of HDIs, the funding formula employed by the South African government, via the DHET, continues to perpetuate historical inequities. The university funding favours the HAIs as more funding is offered for the level of study (honours, master and doctoral qualifications having weights of two, three and four times more than undergraduate qualifications), graduation and research output (Steyn &

De Villiers 2005). This disadvantages HDIs on all levels. For starters, most 'good' students and staff members prefer HAIs as they have better infrastructure, meaning their students will have higher chances of passing, thus improving the graduation rate. In addition, having highly qualified staff members implies they can afford to offer postgraduate qualifications and have higher research output, resulting in more funding than HDIs. On the contrary, HDIs attract less capable students, offer primarily undergraduate qualifications and have low research output.

These inequalities directly affect HDI's ability to provide an environment equivalent to the HAIs. A consequence of inadequately funded HEI is that they will be unable to provide sufficient enablers for using technologies. Universities with insufficient digital infrastructure, such as digital devices and Wi-Fi, and online resources, such as subscriptions to online resources, limit the engagements with technology to both students and staff members. In addition, underfunding means that the universities would invest in inferior technologies compared to universities with adequate funding.

In addition to universities being seen as HDIs and HAIs, another categorisation of HEIs is by geographical location. Universities are found in rural and urban areas. The HEIs that cater for the rural populace and are in rural areas face challenges associated with rural areas. Numerous studies have identified unstable network connectivity and inadequate Internet access as significant barriers to digital learning in South Africa (Makwembere, Matarirano & Jere 2021; Songca, Ndebele & Mbodila 2021). This issue is particularly pronounced for students in remote rural areas, where ICT infrastructure is either minimal or non-existent. Students from remote areas where the connection is challenging are excluded from fully engaging in online learning, even if they have the devices required for such engagements. The digital inequality is exposed by the structures created by the students' locality. Those residing in areas which are difficult to access and have no infrastructure would find it impossible to engage in learning activities. On the other hand, those residing in urban areas, especially in metropolitans, have uninterrupted access to network connections and can actively participate in all expected learning engagements. At this level, digital inequalities affect the quality of interactions, impacting the learning processes of the students. While common in rural areas, network coverage is also an issue with universities in urban areas (Makwembere et al. 2021).

The lack of infrastructure in rural areas is primarily an issue of lack of profitability of any investment. The expensive nature of the digital infrastructure and the poor economic conditions of the rural make it difficult for investors to get a return on their investment. This cannot be said of the heavily populated, urban areas where digital infrastructure is readily available. To exacerbate the situation, some rural areas are not easily accessible, making it expensive to maintain the infrastructure. On the other hand, the huge costs involved in installing such infrastructures and the limited financial resources mean the government cannot afford to prioritise those areas. It is, however, the government's responsibility to create an enabling environment for the effective engagement of all students. The government can reduce inequality through regulations, incentives and negotiations with large corporate organisations that have the resources to invest in the necessary infrastructure.

Policies affecting digital inequalities

The South African government introduced SA Connect in 2013 to achieve broadband school access. By 2020, the objective was to provide Internet connectivity to all schools with a minimum bandwidth of 10 megabits per second, with a strategic plan to increase this to 100 megabits per second by 2030 (University of Chicago Law School – Global Human Rights Clinic 2020). This initiative, along with Universal Service and Access Obligations (USAOs) imposed by Independent Communications Authority of South Africa (ICASA) in 2014, requires telecommunication operators to connect a specific number of schools. For instance, Cell-C, Mobile Telephone Network (MTN) and Vodacom were mandated to provide Internet access to 1500 schools, including 140 for institutions of persons with disabilities (University of Chicago Law School – Global Human Rights Clinic 2020).

SA Connect encompasses multiple components, including Internet infrastructure development, skill enhancement in rural areas, fostering local content creation and improving data and device affordability (University of Chicago Law School – Global Human Rights Clinic 2020). Initially overseen by the Department of Telecommunications and Postal Services (DTPS) and the Department of Communications (DOC), oversight responsibilities were subsequently consolidated under the Department of Communications and Digital Technologies (DCDT) to improve coordination (University of Chicago Law School – Global Human Rights Clinic 2020). Minister Stella Ndabeni-Abrahams, in accordance with *Chapter 12* of the National Integrated ICT Policy White Paper of 2016 and Chapter 4 of the National e-Strategy of 2017, introduced a new policy aligned with these frameworks. This policy aims to enhance digital skills and foster advancements in education and economic development (DTPS 2016, 2017).

In Botswana, the government adopted a policy of funding education from primary to tertiary levels, emphasising literacy in Setswana and English (Matyokurehwa 2013). However, there is a pressing need to strengthen ICT focus at the grassroots level to better equip students for HE. Initiatives encompass the provision of ICT training for educators and investments in submarine cable networks, such as the East Africa Submarine

Cable System (EASSy) and the West African Cable System (WACS) to bolster Internet connectivity (Matyokurehwa 2013).

Universities in South Africa are mandated to comply with the *Protection of Personal Information Act (POPIA) of 2013*, ensuring the safeguarding of personal data and adherence to data protection standards (Anderson, Abiodun & Christoffels 2020). This compliance involves implementing robust policies, defining roles, providing training and adhering to stringent data protection measures. Through the DCDT, the South African government has set up various policies targeting digital inclusion and economic growth. These initiatives are part of the Digital Economy Master Plan and strategies to facilitate digital transformation (DTPS 2016).

Meso level

The meso level focuses on the intermediate analysis level that looks at organisations and structures that connect macro and micro levels. The level is the bridge between individual players and the larger social context. This includes studying organisations, networks and other collective actors that play a role in technology transfer (Cunningham & O'Reilly 2018; Serpa & Ferreira 2019). In the HE sector, these are the institutions of HE. Although there are several HEIs, the focus here is on universities in South Africa. Higher education institutions address the initial barrier to technology access for students through the provision of digital tools and the establishment of a solid foundation for technology readiness (Matarirano, Yeboah & Gqokonqana 2021d). Unfortunately, not all universities can fulfil this role sufficiently. Frequently reported challenges in the adoption and utilisation of technology within HEIs include inadequate ICT support infrastructure impacting Internet access and networking, insufficient technical support, excessive workloads for lecturers and a lack of time for lecturers to instruct students on technology use (Letseka, Letseka & Pitsoe 2018; Nyoni 2020).

It has been almost three decades since South Africa transitioned from apartheid to democracy, but it remains a very unequal society (Letseka et al. 2018). Heleta (2018) argues that universities were created to maintain the unjust structures enacted to serve the needs of the colonialists. Despite gaining freedom, HDIs still face numerous infrastructural challenges (Matarirano et al. 2021b) that limit students' engagement. These inequalities are visible in HEIs where the variance in quality of education between HAIs and HDIs is considered wide. Historically disadvantaged institutions are associated with poor academic performance and appear towards the bottom of rankings despite the parameters used. These ranking parameters include the academic results of admitted students, participation in industry, the number of lecturers with PhDs, the number of researchers, the number of publications and citations and international reputation (Szluka, Csajbók & Győrffy 2023).

The historical legacies mean that HAIs are the preferred destination for most students and staff members, meaning they can attract top-performing students, usually funded by the university's bursary systems. This leaves the average and low performers to be accommodated at HDI institutions. While the average performing students are given nominal access to HAIs, their inability to pay for themselves and low chances of succeeding in their studies in the prescribed time means that HDIs lose out on performance-related government funding. The inability of poor students to enrol at HAIs, which have sufficient facilities, means that most black students are born in poverty, attend basic education in schools lacking adequate resources and then, again, attend HEIs with insufficient resources, completing a vicious cycle.

Most students enrolled in HDIs cannot pay their fees because they have no access to material resources and depend on the government, through NSFAS, for funding (Luckett 2016). As a result, these institutions rely on government grants for funding and cannot afford the latest technology required to enhance teaching and learning. These include modern teaching and learning venues such as laboratories, libraries, lecture halls and Wi-Fi in student accommodations. The insufficient financial resources available to HDIs result in numerous challenges affecting technology utilisation (Matarirano et al. 2021d). Historically disadvantaged institutions are often characterised by subpar academic performance, high dropout rates and low throughput rates (Badat 2010; Boughey & McKenna 2021). Poor academic performance has been associated with inadequate financial resources for enhancing educational quality and enrolment (Badat 2010), insufficient infrastructure and computing facilities (Sonn 2016), and limited staff capacities and capabilities. These resource and capacity constraints perpetuate a cycle wherein underperforming students are admitted to institutions with inadequate resources, leading to consistently poorer outcomes than their advantaged counterparts (Sonn 2016).

The financial incapacity of HDIs was exposed during COVID-19-induced remote learning. When universities agreed to switch to online learning in March of 2020 because of COVID-19 lockdowns, only 10 universities were willing to switch to online by the 20th of April 2020 immediately, and of those 10, only one, the University of Western Cape, was an HDI (Dell 2020). On the contrary, HAIs quickly moved on to technology-infused learning. The University of Johannesburg, for instance, responded swiftly by providing devices to students and Internet data for both students and lecturers (Motala & Menon 2020). Some HDIs, however, needed more than half a year to implement remote teaching (Makwembere et al. 2021). When they did, they provided students with digital devices that were incompatible with some other systems, such as proctoring systems. Failure to have compatible digital devices meant that assessments were unsupervised, compromising the integrity of the assessment results and, eventually, qualifications.

In addition to financial resources, the lack of skills required for online learning also influences digital inequality. The attractiveness of HAIs, where workloads are bearable, and there is immediate support for lecturers, as well as their appealing brands, most 'good' lecturers prefer to work for them. This means that some lecturers working at HDIs lack the digital competencies (Makwembere et al. 2021) required to empower students. During COVID-19-induced remote learning, several interventions had to be implemented to empower and enable lecturers to teach remotely with digital technology (Matarirano et al. 2021a). This is because most lecturers indicated a lack of adequate skills to teach with digital technology successfully. The lack of digital skills by lecturers meant that students could also not enjoy the potential benefits of digital technology.

Policies and cultures of universities also enable and constrain digital inequalities. One such culture is the use of colonial language as a medium of communication, even in the digital space. While an ideal student is well prepared and possesses cultural and linguistic resources to succeed (Luckett 2016), most black students do not have these features. The use of English as a mode of communication in the digital space alienates these students as most black students lack significant exposure to English in their everyday lives.

The primary instructional method of the university is another university factor that plays a role in the extent to which technology is adopted and used. Open and distance learning institutions, such as University of South Africa (Unisa), promote the use of technology in teaching and learning. Students from these institutions are advanced in using technology for learning. Universities that use face-to-face approaches are usually the ones lagging in terms of adopting technology. These are mostly the HDIs, who are, at times, forced to use that approach because of a myriad of challenges, including insufficient financial resources, unstable network connections and lecturers lacking sufficient digital literacy. In between are universities that adopt a hybrid approach to instruction, where face-to-face and technology are equally used. These HEIs integrate technology in and out of the classroom, exposing their students to multiple technologies.

The structure of different academic programmes also leads to digital inequalities among students. There are programmes that infuse the use of technology while others do not (Brown & Czerniewicz 2008). The Competence Framework for the South African Institute of Chartered Accountants (SAICA) academic programme requires that technology be infused into the programme as part of the learning content. The framework specifies that the programme syllabus contains automation, artificial intelligence, blockchain and the Internet of Things (IoT) (SAICA 2021). There are, however, other programmes that do not explicitly require certain aspects of technology in their syllabuses. As such, the SAICA academic programme graduates are conversant with technology, giving them an advantage over those with no such infusion. The same goes for subjects requiring research and completion of assignments using different technologies. The following discussion turns to the microlevel of social analysis.

How do different higher education institutions contribute to digital inequalities?

The University of Botswana (UB) has actively embraced e-learning tools, aligning with policies such as the Learning and Teaching Policy (2009) and the University Research Strategy to 2028 (Gachago et al. 2007). These initiatives strive to enhance educational flexibility through ICT utilisation, as outlined in UB's Strategy to 2028, which places ICT at the core of comprehensive teaching methods. In the South African context, Yende (2021) emphasises the educational disparities between historically white universities, such as University of Cape Town, Stellenbosch University, University of Pretoria, Rhodes University, University of Johannesburg and University of the Witwatersrand and historically black universities, such as Sefako Makgatho Health Science University, University of North-West, University of Venda, University of Fort Hare, University of Limpopo, University of Zululand, University of the Western Cape and Walter Sisulu University, among others). Institutions in rural areas face significant connectivity challenges, which impede digital work and learning.

Despite investments in ICT infrastructure by HEIs, the systems often remain poor and unsustainable (Johl, Von Solms & Flowerday 2013). The South African higher education landscape lacks readiness for the digital society of the 20th century, requiring critical skill acquisition among academic staff (Kanyane 2023). Economic difficulties and socio-economic inequalities restrict students' access to online education, particularly impacting HDIs such as the University of Venda, University of Fort Hare, University of Limpopo, Walter Sisulu University and North-West University. This resistance to technology adoption contrasts with that experienced by well-funded universities like the University of Cape Town, Stellenbosch

University and the University of Pretoria, illustrating a persistent digital divide despite government initiatives (Kanyane 2023).

Statistics from 2014 showed that out of 413 067 academic staff in South Africa, only 132 884 received formal training in basic ICT utilities (Kanyane 2023). Some academic staff members in HDIs resisted digital tools because of a lack of technical training, preferring traditional teaching methods (Kanyane 2023; Mawere, Mukonza & Kugara 2021). While universities like the University of Johannesburg adeptly integrated online learning before the pandemic, rural-based universities encountered resource and skill capacity challenges, perpetuating education inequality (Kanyane 2023; Mhlanga & Moloi 2020). Unequal Internet access in South Africa, especially in remote areas lacking electricity, marginalised certain groups in the education sector amid the digital transformation (Kayembe & Nel 2019; Meyer & Gent 2016). The response to COVID-19 in the education sector lacked uniformity across South African universities, leaving students in rural areas excluded from targeted programmes requiring Internet and computer access (Mhlanga & Moloi 2020).

Micro level

The micro level focuses on the individual users of technology and their interactions in specific social contexts (Serpa & Ferreira 2019). This level examines users' behaviours, attitudes, beliefs, motivations in technology use and the interactions between users (Cunningham & O'Reilly 2018; Serpa & Ferreira 2019). The micro level is the one where individual agency is exercised. Agency is the ultimate factor influencing the adoption and use of technology and exercising agentic powers, which is influenced by the individual's conditioning and external factors. Conditioning informs how individual technology users react to technology events. The mediating factors influencing agency include social structures, ideologies and beliefs (Luckett 2011; Roberts 2015).

Several studies investigating students' readiness for online learning have revealed that most students, particularly those from HDIs, were not adequately prepared (Aruleba et al. 2022b; Matarirano et al. 2021d). Technological readiness encompasses students' willingness to utilise ICT in their academic activities, including accessing, evaluating and adapting learning resources (Van Zyl, Els & Blignaut 2013). Furthermore, Jena (2020) expanded this concept to include the availability of necessary capabilities and resources and students' preparedness to undertake tasks requiring specialised skills and digital infrastructure.

Technology adoption models (TAM) can be employed to examine digital inequalities at a micro level of social analysis. Among these models, the general extended technology acceptance model for e-learning

(GETAMEL) is particularly suitable for elucidating such inequalities. Generally, TAM models converge on the idea that technology adoption is influenced by attitudes and behavioural intentions, which are affected by the perceived usefulness and ease of use of the technology. Various external factors also shape these perceptions. Abdullah and Ward (2016) identified common external factors affecting these perceptions through GETAMEL.

The external factors identified in GETAMEL are, however, not enough to explain the digital inequalities at the microlevel. Other factors, such as the family's situations and demographic features, are also critical in explaining the inequalities and, as such, are discussed separately from factors identified in GETAMEL.

■ Students' experience with digital inequality

Cicha et al. (2021) conducted a study in Poland during the autumn of 2020, over 6 months following the outbreak of the COVID-19 pandemic, which led HEIs in the country to transition to distance learning. The study focused on first-year students, and the findings included the following factors influencing the perceived usefulness of technology: Enjoyment surfaced as the most influential positive factor, indicating that students found satisfaction and delight in their learning experiences. This means that when individuals found using technology enjoyable, they were more likely to perceive it as useful. Self-efficacy and subjective norms also had positive effects, but they were smaller than enjoyment. Higher levels of self-efficacy (confidence in one's ability) and subjective norms (perceptions of social expectations) contributed positively to perceived usefulness. Experience, however, had a negative effect. This suggests that less experience tallies with a lower perception of its usefulness. Computer anxiety did not show a significant impact on perceived usefulness.

The analysis also examined the predictors of perceived ease of technology use, identifying self-efficacy, enjoyment, and experience as having significant and positive effects on perceived ease of use. When individuals felt confident in their abilities, found technology enjoyable and had prior experience, they perceived it as easier to use. In contrast, computer anxiety and subjective norms did not significantly influence perceived ease of use at the 5% level. This suggests that anxiety related to using computers and social influences might not play a significant role in determining how easy technology is perceived to use. Overall, these findings emphasise the significance of enjoyment, self-efficacy and experience in shaping perceptions of usefulness and ease of use regarding technology. They suggest that making technology enjoyable and enhancing individuals' confidence and experience could positively impact how they perceive its usefulness and ease of use.

Conversely, a study conducted by Faloye and Ajayi (2021) at the University of KwaZulu-Natal explored the difficulties faced by first-year students in adjusting to technology-mediated education. A significant percentage (57%) of students reported a lack of basic computer skills, hindering their ability to engage with digital learning tools fully. Additionally, 33% of students struggled because of inadequate facilitating conditions, while 10% faced challenges from unfamiliarity with technology. This lack of familiarity led to heightened anxiety when utilising computers for academic purposes, particularly in handling basic components like keyboards and mice, as well as Word Processing and Spreadsheet Applications. Moreover, the limited use of technology for academic purposes resulted in low competence in computer usage among these students, emphasising the need for increased integration of technology into academic activities (Faloye & Ajayi 2021).

Moonasamy and Naidoo (2022) shed light on the digital disparities prevalent among students, especially those residing in rural areas, constituting a significant portion (77.6%). These students faced challenges stemming from the digital divide, including limited access to the Internet, basic digital tools and connectivity issues. This lack of resources contributed to their dissatisfaction (57.9%) with the sudden shift to online learning during the COVID-19 pandemic. Despite Moodle being a primary platform for accessing learning materials, a notable percentage (15.2%) of students encountered difficulties navigating the system. The major hurdles hindering effective online learning included insufficient network connectivity (67.2%), high data costs (52%), lack of Internet access (28.8%) and unavailability of devices (7.2%) among students (Moonasamy & Naidoo 2022). Mpungose's (2020) study highlights the difficulties encountered during the shift from traditional to online learning, attributing the main obstacle to the existing digital divide. He emphasised the urgent need to customise LMSs such as Moodle to cater to disadvantaged students' unique requirements and limitations, aiming to bridge the gap and enable effective online learning experiences (Mpungose 2020).

Social influence

Social influence refers to the perceived opinions of individuals or groups whose beliefs may be significant to a person (Mathieson 1991). Kemp, Palmer and Strelan (2019) defined it as the user's perception of social pressure to use technology, which is shaped by cultural and normative factors. The beliefs and pressures from influential figures such as parents, religious leaders, friends, peers, student leaders and lecturers significantly impact how students adopt technology. These beliefs are influenced by, among other factors, societal views on gender, marital status, age and religion, such as churches.

Students are the ultimate users of technology, but they are hugely influenced by their lecturers, who are the 'knowledgeable others' according to Vygotsky's Social Learning Theory (Vygotsky 1978). The ideologies of lecturers play a significant role in integrating technology into curriculum decisions and exercising their agentic powers (Roberts 2015). Their conceptions about curriculum, ideologies and beliefs would drive their approaches to technology adoption and use. Students of a lecturer who does not use technology are most likely to be influenced by such beliefs in the related subject and, thus, either do or do not utilise the technology.

Research on the impact of social influence has demonstrated its potential to shape students' behaviour regarding the use of digital technology (Ching-Ter, Hajiyev & Su 2017; Matarirano et al. 2021c; Sarwar et al. 2019). The differences in how the expectations of society influence one create differences in the desire for one to use digital technology.

Technology experience and self-efficacy

Technology experience refers to the skills an individual acquires over time (Ching-Ter et al. 2017). As these skills develop, the user's confidence in using digital devices and related applications will likely increase. In contrast, self-efficacy denotes a student's capability to use available resources to achieve desired outcomes (Bandura 1977). It represents the user's perceived competence to effectively employ acquired skills to engage with ICT systems (Kemp et al. 2019). While possessing digital devices, electricity, stable network connections and data enhances the potential for interactions, the actual use of technology for learning depends on students' self-efficacy. These two factors are interrelated and often difficult to distinguish. Ownership and access to digital technology enhance the experience, positively influencing students' self-efficacy. Khalifeh, Noroozi and Farrokhnia (2020) support this assertion, suggesting that having a device improves self-efficacy as regular use fosters proficiency in utilising applications. Access to and exposure to technology contribute to developing users' technology-related knowledge and skills (Khalifeh et al. 2020; Nami & Vaezi 2018).

Users with experience in utilising digital devices and related applications generally exhibit a positive attitude towards online learning platforms and encounter fewer difficulties in using digital technologies (Abramson, Dawson & Stevens 2015; Ching-Ter et al. 2017). Such users also tend to score higher on the technology readiness index (Matarirano et al. 2021c, 2021d). While access to and proficiency with ICT equipment are fundamental to technological readiness for learning, students with prior exposure to technology are typically better prepared for online learning than those without such experience (Caison et al. 2008; Firat & Bozkurt 2020; Naffi et al. 2020).

Numerous studies have identified experience as a significant factor influencing technology adoption (Abramson et al. 2015; Ching-Ter et al. 2017; Irani 2000; Motaghian, Hassanzadeh & Moghadam 2013; Purnomo & Lee 2013). Experience affects perceived usefulness and perceived ease of use by equipping individuals with the skills and capabilities to use technology and applications effectively. Prior participation in online courses positively affects students' online readiness (Basol, Cigdem & Unver 2018), whereas a lack of experience hampers students' self-efficacy and ability to adapt (Durodolu & Mojapelo 2020). Unfortunately, not all students have access to technology, and those with access are better prepared to adopt and use it. Most students from rural areas or poor social backgrounds, which is most black students, do not have access to digital devices and/or networks and thus are excluded from gaining technology experience. Some students encounter online learning platforms for the first time upon enrolling in HEIs (Czerniewicz et al. 2020; Zimba, Khosa & Pillay 2020). These students lack the skills to use the technology and usually suffer from technology anxiety, while those with experience usually enjoy experimenting with it (Tripathi 2018). Technology experience strongly influences self-efficacy (Cassidy & Eachus 2002; Matarirano et al. 2021c).

Students' readiness to use technology in education is affected by their exposure to and access to technology (Basol et al. 2018; McCoy 2010). In a study where the level of readiness was assessed in an HDI, Matarirano et al. (2021d) found senior students to have a higher technology readiness index. Technology readiness was positively associated with the level of study, and students who had longer access to technology exhibited higher levels of self-efficacy, which enhanced their technology readiness. This implies that the institution provided technology access to students who did not have such access before. Their exposure to technology improved their experience, thus their technology readiness. This perspective aligns with McCoy (2010), who asserts that prolonged exposure to technology leads to skill enhancement, thereby improving readiness for related technologies. Prior experience with technology, largely determined by access, affects self-efficacy (Money & Dean 2019), subsequently influencing the readiness to use technology for learning.

While it is asserted that students possess extensive experience with technology (Basol et al. 2018), an alternative viewpoint posits that the nature of the exposure, rather than the amount, influences readiness to use learning technology. Students' experiences are mostly in social platforms, which do not necessarily translate to readiness to use technology for learning. Although most students are adept at using common technologies because of their pervasive presence, this proficiency does not necessarily translate to an enhanced understanding of technology specifically used for educational purposes (Nami & Vaezi 2018). This assertion is corroborated by Coopasami, Knight and Pete (2017), who found that while students exhibited high general technological readiness, they were not adequately prepared for the demands of online learning. This argument implies that students who have used technology for learning before joining HEIs are at an advantage compared to those without such experience.

Technology anxiety and enjoyment

Technology anxiety refers to an individual's discomfort when using technology (Awofala, Akinoso & Fatade 2017). Venkatesh et al. (2003) describe technology anxiety as the 'evocation of anxious or emotional reactions in response to performing a behaviour'. It is a state of uneasiness related to the use of ICT (Kemp et al. 2019) and is typically associated with unfamiliarity, often resulting in resistance to change (Awofala et al. 2017). As a result, there is a close relationship between technology experience and technology anxiety. Students who have experience in digital technology and utilise it in their daily lives are unlikely to have technology anxiety. On the contrary, those lacking access are most likely to have challenges in adopting technology for learning.

Technology anxiety significantly affects the adoption of learning technologies in HE (Alenezi, Abdul Karim & Veloo 2011). It negatively influences students' perceived ease of use in e-learning environments (Al-Gahtani 2016; Awofala et al. 2019) and impacts their perceived usefulness of technology (Awofala et al. 2017; Ching-Ter et al. 2017; Purnomo & Lee 2013), ultimately affecting its acceptance (Matarirano et al. 2021c).

Technology anxiety and technology enjoyment represent opposite aspects of the same concept. While anxiety denotes a sense of fear, technology enjoyment reflects the intrinsic motivation to derive pleasure from using technology (Chao 2019). It is the extent to which the use of digital technology is considered enjoyable in itself (Kemp et al. 2019). Enjoyment is positively correlated with perceived ease of use and perceived usefulness (Hanif, Siddiqi & Jalil 2019; Sarosa 2019), as well as the intention to use technology (Sarosa 2019). Users are more likely to adopt and utilise technology if it is perceived as enjoyable. Students who have experience using technology, and thus have technology self-efficacy, are more likely to enjoy its use than those without experience. Technology self-efficacy was significantly related to enjoyment (Matarirano et al. 2021c).

Computer anxiety and enjoyment are most likely to be influenced by other variables, such as access to digital devices, networks and data, which, in turn, influence enjoyment and anxiety. Historically disadvantaged institutions that are in rural areas have features of having students with low technology readiness because of technology anxiety, while urban and HAIs are likely to harbour students with higher levels of technology enjoyment and high technology readiness.

Family situations

Black students from disadvantaged social backgrounds lack the prerequisites for digital technology. Luckett (2016) argued that most black students are 'subjects' who have no access to material resources and depend on the government for study funding (Luckett 2016). This explains the majority of students found in HDIs. They do not have digital devices, and their home environment impedes their learning (Mohmmed et al. 2020; Obuaku-Igwe 2020). This is why many students prefer to be on campus rather than at home (Matarirano et al. 2021a). University campuses offer refuge from social injustices by providing access to the university's Internet network, study spaces and discussion areas (Makwembere et al. 2021). These resources and study spaces, often unavailable in home environments, support students' academic activities. At home, many students who share spaces with their families and have numerous family responsibilities and household chores find their time for engaging with learning content significantly limited (Matarirano et al. 2021a). Their limited access to material resources means they cannot engage in learning fully. On the other hand, most students in HAIs have families with adequate financial resources to provide for their needs. These students' home environments offered a conducive learning atmosphere (Parker, Hansen & Bernadowski 2021).

The language spoken at home and in the community is another source of digital inequality. Digital applications are primarily in English and a lack of proficiency in the English language disadvantages non-English speakers. Lack of linguistic proficiency in the colonial languages is considered a source of alienation for most black students (Heleta 2018; Luckett 2016), leading to different levels of digital literacy. Students lacking English proficiency are likely to lack technology self-efficacy and suffer from technology anxiety.

Demographic factors

Parasuraman and Colby (2014) assert that demographic characteristics such as age and gender are correlated with technology readiness. Younger students are generally considered to have higher readiness for online learning because of their upbringing in a technology-rich environment, resulting in higher levels of technology self-efficacy than older students (McCoy 2010). This assertion is supported by Caison et al. (2008) and Rojas-Méndez, Parasuraman and Papadopoulos (2017), who found that older students tend to have lower technology readiness scores. However, Blut and Wang (2020) discovered that age negatively affects the motivators of technology readiness, suggesting that older individuals are more likely to use technology than younger ones, a finding corroborated by Firat and Bozkurt (2020) and Matarirano et al. (2021d).

While it is theoretically accepted that male students are more inclined to use and learn about computers than female students (González-Gómez et al. 2012), numerous studies on gender and technology readiness for learning have yielded inconsistent and varied results (Goswami & Dutta 2016). Brown and Czerniewicz (2009) suggest that these mixed findings indicate the issue may be context-dependent and influenced by factors such as socio-economic status, language, culture and academic discipline. Caison et al. (2008) found that male students scored higher in innovation and had a more positive overall technology readiness attitude than female students, as supported by Rojas-Méndez et al. (2017). Nami and Vaezi (2018) also found that male respondents exhibited higher technology self-efficacy than female respondents. The greater willingness of males to experiment and the enjoyment derived from it may contribute to this higher self-efficacy. In some cultures, women are not encouraged to be inquisitive, which may reduce their interest in being adventurous and using new technologies.

Male students tend to adapt more quickly to the use of technology than female students. Learning from home or other non-university environments has proven ineffective because of potential distractions that impede learning and comprehension. This challenge is particularly acute for female students, especially in Africa, where specific responsibilities are often considered gender-based. Statistically, female students exhibit higher levels of anxiety (Aruleba et al. 2022a). Studies indicate that gender significantly influences the adoption of new technology (Venkatesh et al. 2003). Recent research, however, suggests that gender gaps are gradually diminishing because of increased early exposure to technology (Korlat et al. 2021). Despite the growing technology access and use over the years, significant inclusion challenges remain in ensuring women's active engagement in transitioning to a digitally enabled society. There is a considerable gender gap in information technology (IT) access, typically favouring males (Aruleba et al. 2022a). This issue is exacerbated for students who are also parents, who must balance family responsibilities with their studies (Czerniewicz et al. 2020; Shin & Hickey 2020).

Linking the macro, meso and micro levels

The interplay between these levels influences access to resources, learning conditions and educational outcomes. This section discusses the specific government policies and institutional operations that drive these dynamics.

- *Government policies and institutional operations*: Government funding formulas favour HAIs, creating financial disparities. This influences the resource allocation in universities. Historically advantaged institutions attract top-performing students and staff because of better infrastructure and resources, leaving HDIs with fewer resources and less qualified staff.

This impacts HDIs' abilities to offer higher-level qualifications and conduct extensive research, perpetuating the divide.

- *Geographical divide and institutional infrastructure*: Rural HDIs face infrastructural challenges because of poor network connectivity, hindering effective digital learning. The cost inefficiency of investing in rural areas affects the availability of digital infrastructure, leading to unequal access for students based on their locations. Historically advantaged institutions, predominantly in urban areas, benefit from better network coverage and technological resources.
- *Institutional resource allocation and individual technology use*: Inadequate resources at HDIs impact students' readiness for online learning. Students' technological readiness, influenced by the institution's provision of digital tools and infrastructure, affects their ability to engage effectively with technology.
- *Institutional culture and policies and student behaviours*: Policies emphasising English as the primary language of instruction, especially in digital spaces, create disparities for students less proficient in English. This affects the attitudes and behaviours of individual students towards technology use, influencing their perceptions of usefulness and ease of use.
- *Individual agency and government policies*: Students' readiness for online learning and their technological competencies feed back into the larger structural issues. The lack of readiness among students in HDIs, influenced by individual agencies, reflects the inadequacies in government policies regarding resource allocation and infrastructure development for these institutions.
- *Student experiences and institutional operations*: Negative experiences of students during remote learning periods, such as the inability to fully engage, showcase the impact of macro-level policies on the micro-level experiences. This feedback loop can influence the government to reconsider funding formulas and allocation strategies. These interactions demonstrate a continuous feedback loop where macro-level policies influence meso-level institutional operations, affecting individual experiences and behaviours at the micro level. In turn, individual behaviours and institutional capacities feed into shaping and potentially reshaping macro-level policies and resource allocation strategies.

■ Actionable recommendations

Governments and policymakers should enact comprehensive policies to bridge the digital divide, focusing on equitable distribution of resources, infrastructure and training programmes. Public-private partnerships can be used to subsidise the lower profitability associated with investments in rural areas. The subsidies may be applied in terms of incentives such as tax breaks, which would encourage private organisations to partner with the government to provide services to remote areas.

Another recommendation is to allocate adequate funding to address problems for HDIs in order to improve digital infrastructure. Formulating inclusive policies to ensure rural areas have adequate digital infrastructure and connectivity. The current policies have, however, not been sufficient in dealing with the issues. The National Integrated ICT Policy White Paper (2016) aims to create an inclusive knowledge economy and information society by ensuring that all South Africans, including those in HE, can access quality and affordable ICT services. The policy focuses on expanding broadband infrastructure and providing universal access to digital resources.

The most recent policy to be developed is the National Digital and Future Skills Strategy by the Department of Communications and Digital Communications (DCBT) (2020). This strategy explains the development of digital skills across different sectors, including education (DCBT 2020). It aims to equip educators and students with the required digital competencies to effectively engage with technology-enhanced learning environments.

Strategies should be developed to ensure equitable distribution of resources between historically advantaged and disadvantaged institutions. Ensuring all students have equitable access to learning materials and resources is essential. This includes ensuring access to online libraries, providing free or subsidised digital textbooks, and creating repositories of open educational resources. Regarding the distribution of resources, the DHET has the following current policy: DHET Policies. The DHET has implemented many policies to improve digital inclusion in HE. These include the provision of data packages and laptops to students, particularly those from disadvantaged backgrounds. The DHET also negotiated zero-rated access to educational websites to ensure students could access online learning materials without incurring data costs. Nevertheless, more work still needs to be carried out to enhance training and support for educators to integrate technology into their teaching methodologies effectively and customise LMSs to cater specifically to the unique needs of diverse student populations.

In addition, efforts should be made to provide basic computer skills training for students, especially those from disadvantaged backgrounds; create initiatives that boost confidence in using technology and reduce computer anxiety; and offer support programmes for students facing connectivity and device-related challenges. It is also essential to encourage collaboration between government bodies, private sector stakeholders and educational institutions to implement innovative solutions for improving digital access and infrastructure. Moreover, efforts should made to facilitate the provision of subsidised or affordable devices and data for students from underprivileged backgrounds.

While the following policies have been developed, further efforts are still needed to address digital inequality.

One policy is SA Connect: National Broadband Policy. This policy aims to provide universal broadband access through collaboration between government, private sector and educational institutions. It includes strategies to improve infrastructure and ensure affordable Internet access for all citizens. The other policy is Zero-Rated Educational Websites: The DHET, in partnership with telecommunications companies, has negotiated zero-rated access to educational websites. This allows students to access online learning materials without data charges, fostering collaboration between the government and the private sector to support students. It is vital to regularly assess the effectiveness of policies and initiatives implemented, adapting strategies based on ongoing evaluations and feedback from diverse stakeholders. Addressing digital inequalities in HE requires a multi-faceted approach involving policy reforms, resource allocation, skill enhancement and collaborative efforts across various levels of governance and institutions. The goal is to create a digitally inclusive environment that empowers all students and educators to thrive in a rapidly evolving technological landscape.

■ Conclusion

While antecedents of inequality and the related levels were discussed separately, inequality is a consequence of an interplay of several factors within the discussed levels, those within the control of individuals, yet others are external. The external factors and the experiences of technology users condition the students to exercise their agency to use or not use digital technology, resulting in inequalities. The use of technology in learning, which some students cannot access, either through inaccessible devices, networks, data or inability to use the devices and their applications, means that student interactions are constrained by technology, thus alienating them. Vygotsky's socio-cultural theory of learning and development (1978) posits that learning occurs within social contexts, emphasising the critical role of interactions. Lack of students' interactions with content, their peers, lecturers and other experts because of not having digital devices, Internet access or the ability to utilise the technology reduces their chances of success, widening societal inequality. Digital inequality in a digitally enhanced HE system limits the participation of other students, constraining knowledge development. The eventual inequality is that some students have epistemology access while others do not. Those with epistemology access will have better access to jobs and business opportunities, increasing their chances of success.

The different internal and external factors discussed at different social levels show that digital inequality exists between HEIs, students in different HEIs and locations, within the same institution, and similar programmes and subjects. Technology, not only in HE but also in society, has become one of the basic human needs. By creating access to technology for the whole society, digital inequality in HE will be reduced. Coordinated and concerted efforts are required if the gap in digital inequalities in HE is to be reduced. Unfortunately, as it stands, structures and cultures within societies continue to widen rather than reduce the gap. In reducing the digital inequities in HEIs, decision-makers should consider changing the structures, especially at the macro level. As meso and micro levels operate within the realm of the macro level, a change in the policies and provisions at the macro level will have a ripple effect on the other two levels. The South African government, at the macro level, should create policies that give digital access to the poor and the marginalised. If carefully designed at the macro level, the effects of such policies will filter down to lower echelons of society, giving technology access to the marginalised and creating a digitally inclusive HE system and society.

Digital disparities in HE are deeply rooted in historical, economic and geographical structures, perpetuating inequalities between historically advantaged and disadvantaged institutions. Historically disadvantaged institutions face significant challenges because of underfunding, leading to inadequate infrastructure, limited access to technology and lower academic performance. While aiming to bridge the gap, government policies often fall short in addressing the fundamental issues, creating limitations in digital access and readiness. Within institutions, varying approaches to technology adoption, infrastructure limitations and academic programme structures contribute to disparities in technology use among students and faculty. Individual student experiences, affected by factors like computer anxiety and limited access to devices and networks, greatly influence their readiness and success in digital learning environments.

The next chapter delves deeper into the issues identified, focusing on the experiences of first-year students in a South African HEI. It explores the interconnectedness of digital inequality with social and economic factors, including social stratification, gender stereotypes, cultural norms and geographical location. The chapter highlights the challenges faced by students from disadvantaged rural backgrounds and how ICTs may be used to bridge the gap in the digital divide. Using Nancy Fraser's Normative Theory of Social Justice, the chapter argues for identifying and mitigating identified digital inequalities to ensure equity that counters historical injustices entrenched by economic, social and political factors.

Chapter 3

Social, economic and digital inequalities among students at South African universities

Thandokazi Mfikoyi
Directorate of Learning and Teaching,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Sibulele Yawa
Directorate of Learning and Teaching,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Bulelwa Mkabile-Masebe
Department of Business Management Education,
Faculty of Education, Walter Sisulu University,
Mthatha, South Africa

Abstract

Digital inequalities in higher education create barriers to effective learning. This is especially true for students from disadvantaged rural backgrounds with no previous exposure to learning using technologies. This chapter examines the intersection of digital inequality with social and economic factors, focusing on the experiences of first-year students in higher education institutions in South Africa. The chapter explores how social stratification, gender stereotypes, cultural norms, late technology adoption

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and geographical location contribute to digital inequalities in higher education. It exposes the impact of these inequalities on students' access to and use of digital technologies, highlighting the challenges faced by students from disadvantaged backgrounds. The chapter aims to establish the relationship between the digital literacies of first-year students and their social, economic and technological status, and how these factors influence their ability to learn and succeed using technology. These students are typically black and come from Quintile 1 schools, which are categorised as the poorest based on national poverty rankings, considering the poverty levels of the surrounding community and the school's infrastructure.

Introduction

Chapters 1 and 2 have pitched the different forms and types of digital inequalities in South Africa, specifically in higher education. This chapter presents more details on inequalities, emphasising the common facets such as social, economic and technology. The target participants for this chapter were first-year students selected from an institution in South Africa. It is evident that technology integration in education has emerged as a transformative force, offering new and improved ways for student learning and engagement. Expanding on Chapter 1, digital inequality is multifaceted; it encompasses more than just access to information and communication resources. It also includes the nuances of when individuals or communities adopt digital technologies. Examining digital inequality through the lens of late adoption provides a nuanced perspective that can inform strategies for a more inclusive digital future. While the term may initially evoke a sense of lag or reluctance, it is crucial to recognise that late adoption often results from various factors, such as socio-economic constraints, cultural considerations and educational opportunities. Analysing digital inequality from the perspective of late adoption reveals a complex web of interrelated causes.

Understanding social, economic and digital inequalities in the context of South African higher education

Studies have shown that integrating technology into the classroom benefits students, teachers and educational institutions (Adeshina 2024; Haleem et al. 2022). Technology enables more engaging and interactive learning environments, better prepares students for the digital future, supports diverse learning styles and fosters student collaboration. It also allows teachers to address individual student needs effectively and facilitates communication between students and teachers.

Scholars have noted that adopting and effectively using educational technology is not universal. There is evidence that the disparities exist in knowledge, skills, resources and infrastructure, which can determine whether technology is incorporated into the curriculum. Van Dijk (2020) argues that digital technologies have increased social, economic and cultural inequalities in many parts of the world. This is true for rural students from disadvantaged backgrounds coming to university for the first time, who might have no prior knowledge of learning using technologies (Ndebele & Mbodila 2022) because of their schooling background, geographical locations, socio-economic and cultural background (Oyedemi & Mogano 2018). Scholars have identified digital inequalities as a barrier to learning and teaching, and several studies have focused on access to the Internet and other forms of the digital divide (Faloye & Ajayi 2021). This also includes the exclusion of students living with disabilities.

Hsieh and Arun Rai (2008) and Asmar, Mariën and Van Audenhove (2022) highlight the role of socio-economic constraints, with Hsieh emphasising the impact of personal network exposure and enjoyment and Asmar presenting a model that combines social and digital indicators. The persistence of digital inequality, particularly in rural and regional areas, among older individuals and those with low income and education levels. These studies underscore the need for nuanced strategies to address digital inequality, considering the diverse factors contributing to late adoption.

The authors agree that digital inequalities in South Africa stem from the historic, skewed and unequal apartheid of South Africa. Interestingly, as a form of enduring inequality, historically black universities (HBUs) in South Africa, also known as historically disadvantaged institutions (HDIs), were created through the apartheid laws as a form of separation for black and white population groups. A differentiated funding formula was used to provide resources and infrastructure for historically white universities (HWUs) differently from HBUs. Bozalek and Boughey (2012, p. 670) assert that even 'the programmes these different kinds of institutions could offer were also defined by apartheid beliefs about the roles considered appropriate for different social groups'. These institutions survived the apartheid savagery, and as such, their geographical location continues to create access for students from poor rural backgrounds. In this context, we exclaim that after 29 years of democracy, South African society is still plagued with social, economic and digital inequalities. These inequalities manifest themselves in various aspects and spaces in society. These are, arguably, because of the social stratification that, during the apartheid era, manifested itself through race. In post-apartheid South Africa, however, these inequalities have found other avenues of expression in issues such as gender and class differences. Social stratification remains an area of concern regarding how people can access certain resources that enhance their quality of life.

Social stratification limits how people live and access essential resources, and this results in inequalities in the quality of life and experience people may have. Social stratification is further played out in how people access essential services such as quality education and technological infrastructure and how they experience this access. This stratification is evident in various spheres; the higher education sector is one such sphere. The hierarchy is such that more affluent people have better and easier access to quality higher education. Previously clamoured by racial differences, today, class, schooling background and geographical location are the main determinants of who and how students access higher education and how they benefit and experience learning in these institutions. Studies have shown that access to Internet connectivity and digital devices is critical to students' perceptions of their technology experiences (Liebenberg et al. 2012; McIntosh 2023). Students tend to be more satisfied with their Internet connectivity when on campus than off-campus experiences. While students may have access to technology, the ability to effectively utilise it for learning varies greatly. Some students exhibit strong digital skills and can navigate online resources, digital technologies and the learning management system (LMS), while others lack the necessary knowledge and training (Liebenberg et al. 2012). One of the avenues in which this is evident is the glaring disparities in technology and digital literacies upon entry into university.

Therefore, it can be argued that the social, economic and digital inequalities in South African higher education continue to create barriers to learning. There is a need for transformation, equity and redress to address past inequalities. The chapter moves from the generic observations of the social and economic inequalities using case studies as secondary data from various African countries. Then, it highlights how these inequalities contribute to technological and digital inequalities using the case of first-year students in higher education institutions (HEIs) as a reference.

The chapter further illustrates the importance of ICTs in higher education and its potential to bridge these inequalities. Reflecting on Nancy Frasers' normative theory of social justice, a recommendation is made for HEIs receiving students from rural backgrounds to identify these inequalities and design programmes that will increase participation and representation to ensure that equity of access can translate to equity of outcomes and thus, counter the effects of these historical disadvantages that are entrenched through economic, social and political disadvantage. The chapter presents primary data as support to illustrate how the economic and social inequalities contribute and, to an extent, determine the digital inequalities and disparities in first-year students in a historically disadvantaged university in South Africa.

Theoretical framework

Social, economic and digital inequalities are a social phenomenon affecting all groups of people's human lives, daily living, employability and productivity. Nancy Fraser's three-dimensional theory of social justice (2008, 2009) provides a lens through which the authors attempt to understand, assess and analyse the choices and actions of the participants. Fraser (2005) views inequalities as social injustice because of the failure to participate as equals in social life. She proposes three dimensions that affect what she calls 'parity of participation': economic, cultural and political. Fraser's theory suggests that participation parity is hindered if individuals are marginalised or deprived of access to economic resources, cultural recognition or political status, impeding their ability to participate equally with their peers. Using this theory helps surface the default contexts that new students may bring to higher education. Extending key definitions from Chapter 1 by different experts, Fraser's three dimensions that affect participation parity can be defined as follows:

- *Economic inequalities*: This may result from a lack of proper infrastructure, resources or materials, including digital literacies (Hodgkinson-Williams & Trotter 2018) before these students enter university. Fraser suggests that economic maldistribution can be addressed through economic redistribution or restructuring.
- *Cultural inequalities*: These arise from the misrecognition of cultural values, epistemic positions and cultural hegemonies that may be found in the curriculum (Hodgkinson-Williams & Trotter 2018). Fraser proposes that these can be addressed through recognition.
- *Political misframing*: This includes power dynamics, lack of exposure, lack of access and general social exclusion in decision-making processes. Social inclusion can be difficult for a group disempowered by economic status and cultural misrecognition. The legacy of coloniality and apartheid in South Africa exacerbates these challenges, and redressing these issues may take considerable time.

Fraser's three-dimensional theory is relevant for investigating social, economic and digital inequalities in this context. This theory will provide an in-depth understanding of the inequalities in question and further guide and propose strategies that may lead to the transformation or emancipation of the marginalised groups.

The context of the chapter

This chapter examines the experiences of first-year students in a HEI in South Africa. The authors draw on their experience of more than 37 years combined in teaching using digital technologies and supporting lecturers in higher education. The chapter reflects on a case study conducted among first-year students at an HBU to determine their digital literacy levels and assess the impact of these experiences on their learning using digital devices and the LMS. The first-year students are subjects in this chapter because they provide good indicators of students' ability to bridge the digital inequality gap to enable them to learn and succeed using digital technologies during their initial university years. The chapter discussion is based on the findings from a study that was conducted as a pilot; however, this sample represents many students with similar characteristics who come from Quintile 1 schools categorised as poor across South African higher education institutions.

A mixed method approach was used to provide mixed data sets that will assist in integrating the quantitative and qualitative data relating conceptually and analytically to students' perceptions and experiences of digital inequalities. An explanatory sequential data collection design was used. Data from university documents were also used, such as the Student Academic Readiness Survey (STARS), 2022/23. Data Collection and Sampling Data were collected from a target population of 7200 first-year students, where at least 61.95% (4461) voluntarily participated in the survey. All participants were South Africans from different provinces, meaning Eastern Cape, KwaZulu Natal, Limpopo and the North-West. This random quantitative sample of students was followed by focus group interviews from a purposeful sample of students from existing strata (students per campus) to share their experiences on digital inequalities.

The study revealed that students from lower rankings in terms of social stratification tend to be less technologically and digitally savvy. More than 70% of students who took part in the survey indicated that they had no access to resources such as a laptop or Internet before coming to university. This challenges these students as some teaching and learning is done using digital devices such as laptops or desktops. Students from disadvantaged backgrounds battle to find their feet and need to be trained and skilled in using digital literacies. Many universities utilise laptops and tablets as an integral part of the learning experience. These devices are used for accessing online course materials, participating in virtual classes, submitting assignments and engaging with LMS for content delivery and assessment, thus offering synchronous and asynchronous learning.

Social inequalities

In this chapter, social inequality refers to imbalances in the distribution of and access to resources, opportunities and essential services such as health care and quality education (Kerbo 2003). Previously, in South African history, race was the key determinant of whether people could access resources, opportunities and essential services. Quality higher education is one of the opportunities privy to a certain group of people but even post-apartheid, there remain some disparities in access to higher education. However, the issue is no longer access but rather how well prepared and equipped students entering HEIs are. This means even those students who do get the opportunity to come to higher education institutions, to a certain extent, get affected by factors such as social, economic and digital inequalities. These factors determine their experience at HEIs.

Social inequalities can arise from numerous factors, such as cultural norms and practices, gender stereotypes and biases, social classes, geographical location and historical factors. These factors affect the student and how the student performs in different ways.

Gender stereotypes and biases

One of the contributors to social inequalities is gender stereotypes and biases, particularly when it comes to women. Sultana (2015) posits that the 'Construction of gender within the society creates different patterns of expectation for both men and women, which lead to different behaviours'. Judith Butler (1988) also highlights that gender is performative and not necessarily determined. The period of apartheid, spanning from 1948 to 1994, posed significant challenges to the progress of women in higher education. Throughout this period, women were underrepresented across all tiers of higher education establishments (Mdleleni, Mandyoli & Frantz 2021). Traditionally, women were assigned non-egalitarian responsibilities like taking care of the home and keeping a low profile in the workplace (Sultana 2015). This arose from societal cultures and norms, even though there was no structured mechanism for it, and it has largely contributed to social inequalities as women tend to be left behind (Rao 2021). The case of gender inequality driven by cultural, and societal cultures and norms rather than formal structures is still prevalent. 'Cultural inequality is intertwined with social, political and economic issues that [lead to] inequality in income, wealth, gender, information, principles, arts, regulations, standards, values, and other abilities' (Aktar & Alam 2021).

Because of this, most women could only get low-income earning jobs and could not afford good education opportunities for their children if the children's fathers were not in their lives. This resulted in a cycle where children from women-headed homes had limited access to quality education and were, therefore, stuck in the same positions that their parents were. They could not get higher. In the case where women did get the opportunity to be educated, they could only get so far in the workplace. There was always a glass ceiling that they could not go beyond (Cotter et al. 2001). The glass ceiling refers to how women in the corporate space can see the top and are adequately qualified but could never get beyond certain levels. Taparia and Lenka (2022) define the glass ceiling 'as an invisible barrier that prevents qualified women from upward advancement in the corporate hierarchy'. For instance, women could be adequately qualified, or perhaps even more qualified than the men in the company, but when considering someone to promote, the company is most likely to consider the man first. Thus, 'broadly, compared to men, women face gendered structural barriers constraining their opportunities in the [labour] market' (Cech & Blair-Loy 2010). This, again, causes women to remain marginalised and affects their own as well as their children's access to opportunities, essential services and resources, which translates to social inequalities.

A study by Morley, Leach and Lugg (2009) explores participation in higher education, particularly focusing on the intersection between gender and socio-economic status and whether they facilitate or constrain participation in higher education. The study was conducted in two public and two private universities in Ghana and Tanzania. Morley et al. (2009) point out that the participation of women in higher education remains low in sub-Saharan Africa despite the 'feminisation of higher education in high-income countries. This refers to how women increasingly attend, participate and succeed in higher education'. More women are now entering the higher education space and are doing well even though they previously, in some places, were not allowed to enter the higher education space. Morley et al. (2009) further aver that the data obtained from life history interviews has demonstrated how socially prescribed family responsibilities and gendered labour divisions impact women's potential to engage in education at any level. One of the respondents in the study had this to say:

> As for me, I am a married woman, so I find it very tiresome because I have to do some domestic work and do the reading so I cannot meet the standards … there have been a lot of problems; maybe you plan to do this, and there are interferences like you have visitors at home … and other domestic problems that are hindering my studies (Morley et al. 2009, p. 60)

One can, therefore, see that the divisions of labour and other socially prescribed responsibilities put women at a disadvantage, especially in rural environments.

This study discovered that men from higher economic groups were more likely to enter HEIs than women. This could be because of the colonial legacy wherein colonial officials recruited upper-class men to attend higher education so they could serve the colonial state and oversee the natives (Mama & Barnes 2007). Morley et al. (2009) argue that sub-Saharan Africa continues to have low female participation in higher education. This study also found that although women may have access to higher education, finding the balance between their socially prescribed responsibilities and university careers remains a struggle. They conclude that:

> [*W*]omen's engagement with formal systems of education is mediated by their bodily stages. The emergent female body signifies a problem for formal educational systems. Higher education is often seen as incompatible with women's bodies and lifestyles. (Morley et al. 2009, p. 60)

Additionally, gender stereotypes have been an issue for women in the higher education context because women were seen to fit into specific disciplines and not in others. A woman participating in Morley et al.'s (2009, p. 60) study commented that:

> When you go out there and tell people that you are an Engineer, they take it as if a woman cannot do Engineering work. They see you as genius, so that makes me feel good.

Because women were expected to fit into 'traditional disciplines' such as the social sciences and the arts, a woman who decided to pursue a career outside of these disciplines was regarded differently than other women. Women who pursue non-traditional fields are still viewed as cultural outcasts, regardless of whether they are portrayed as geniuses or abnormals (Morley et al. 2009).

Morley et al. (2009) found that gender identity and academic fields are related. There is a perception that if a subject is 'hard', meaning a 'hard science', it is unsuitable for women, as a Tanzanian Female Engineering student relates:

> Q: How many girls are you in your class?
>
> A: We were eight, but now we are only three girls.
>
> Q: Where are they?
>
> A: They thought the course was so difficult they . . . dropped it.
>
> Q: They went to another profession?
>
> A: Yeah, they went to teaching.

Research indicates that women often have lower self-esteem and confidence in academic settings than men, which can impact their decision to enter HEIs, even if they come from supportive economic backgrounds (Crawford & Greaves 2015; Ma 2023).

Cultural norms and practices

On the same token, cultural norms and practices may contribute to the social inequalities evident in South African society. Because of the diversity of cultures in South Africa, it is easy to marginalise other cultures because their way of doing things differs from how one's culture does them. The influence of colonialism and apartheid has significantly shaped contemporary South African culture (Maluleke 2012). Many cultural norms now considered ‘traditional’ were constructed or altered during colonial times to serve the interests of the colonisers. For example, the primogeniture rule, which favours inheritance by the firstborn son, is argued to be a colonial imposition rather than a traditional African practice. This historical context is crucial for understanding current social inequalities, as the legacy of these imposed norms continues to affect societal structures and relationships. According to Maluleke (2012), some cultural norms are beneficial to all members of the community, while some are harmful to a specific group like women. These include early forced marriages, ‘ukuthwala’, and the widow’s custom of marrying the brother of your deceased husband as a woman, ‘ukungenwa’. These cultural norms and beliefs limit women’s access to educational opportunities (Fact Sheet No. 23 2013). Practices that enforce strict gender roles can lead to social isolation of women, limiting their networks and support systems. This isolation can prevent women from accessing information and resources available online, further entrenching digital inequality.

Geographical location

This is another crucial factor to consider as far as social inequalities are concerned. This speaks to the urban-rural disparities that limit access to resources and essential services. Those in more urban settings have easier access to the necessary resources, unlike those in more rural settings. In more rural settings, limited infrastructure may lead to issues such as limited connectivity and limited access, as it may not be beneficial for service providers to set up their businesses in these spaces and for the HEIs to provide the necessary infrastructure and resources to help the students. In the South African context, most people living in rural areas live on social grants provided by the government and, therefore, cannot afford these services. Thus, when a resident leaves the rural geographical area and moves to urban areas, they are already at a disadvantage and behind their peers because of a lack of exposure to these resources and services.

Sion Yang (2023) explored the spatial inequalities in a rural HEI in a developing, low-income country using a qualitative case study to establish student experiences in the Kumi District of Eastern Uganda. Some of the findings revealed that some students did not have access to infrastructure or digital devices that afforded them a decent level of education before entering university (Yang 2023). Findings reveal problems associated with limited infrastructure and economic constraints as students from rural areas often face financial difficulties that hinder their ability to pursue higher education. During the coronavirus disease 2019 (COVID-19) pandemic, because physical contact had to be minimalised and learning and teaching had to happen remotely, at Kumi University, all educational activities had to be suspended because their students are from rural areas and could not participate in online teaching and learning activities because of lack of access to devices and the Internet.

Yang's (2023) study also found that rural areas are disadvantaged because of a lack of adequate human resources in the form of lecturers at a rural HEI. This study revealed that the rural HEI in Kumi District suffers from a lack of qualified and experienced lecturers, which directly impacts the quality of education offered. This further exacerbates the gap between urban and rural settings. The shortage of lecturers in a rural HEI has been primarily attributed to low pay and less appealing working and living conditions (Bashir et al. 2018). Furthermore, because these academics may look for better career growth opportunities, the rural HEIs may suffer from a brain drain, which Yang (2023) defines as the phenomenon where highly skilled professionals leave rural areas for better job opportunities in urban areas or abroad. Given these glaring urban-rural disparities, one can infer that, indeed, social inequalities remain a problem in the context of higher education.

Thus, geographical location can pose a challenge to those in rural areas who may have limited or no access to these resources. Higher education institutions located in rural areas will be particularly challenged to ensure that their students have the necessary and adequate resources to ensure that they are not technologically left behind. Lembani et al. (2020) argue that even though digital technology is present almost everywhere, there is a digital divide in the world, which is a result of regional variations in technological infrastructure, the application of technological strategies in developed and developing nations, and disparities between urban and rural areas.

Historical factors

Factors such as colonialism and apartheid are issues that may also contribute to social inequalities. Because these were systems that worked and thrived because of the subjugation of certain groups of people while others continued to hold power, those who were subjugated and oppressed remained marginalised. In the South African context, under apartheid, it was largely black people who were subjugated and marginalised. This meant even the higher education system was constructed along racial lines (Mekoa 2018). Black people attended their own universities, while white people had their own. These HBUs were largely based in rural areas that lacked adequate infrastructure and were not adequately funded, so this placed the institutions at a disadvantage.

This had an impact on the access they had to essential services and resources. This also meant that these institutions could not get access to digital developments and that the black students who attended these universities were left behind with technological advancements. The white minority enjoyed high-quality education, while students from other racial groups received below-par instruction in schools lacking in contemporary technology (Faloye & Ajayi 2021). The legacy of the apartheid era is still prevalent in HEIs currently, according to a survey conducted by Cox, Cheng and Forbes (2018). In their survey of students in ten South African universities, they discovered that white students had more access to technology tools such as the Internet and computers at home than their black counterparts, which already sets the black students at a disadvantage.

Economic inequalities

In this chapter, economic inequalities refer to the uneven distribution of wealth and resources (Weisskopf 2013). Economic inequality plays out in how individuals or social groups are hierarchically stratified according to their economic position. As one may imagine, there is an interconnection between social inequalities and economic inequalities. As a result, some of the factors leading to or contributing to these inequalities are somewhat similar. Literature reveals that some causes or factors leading to these inequalities include, but are not limited to, the consequences of skill-biased technological advancement (Card 2001), which speaks to how the market rewards those with the necessary education and technological skills that keep with the times. Educational level is, therefore, an important factor that determines the economic inequalities in society. Thorson and Gearhart (2018), in their study on the adverse effects of economic inequality on educational outcomes, argue that 'a country's level of economic inequality has large, negative effects on its student academic achievement'. Those who are less educated or uneducated are more likely to be on the lower rungs of the economic ladder. However, those who have access to education may still feel the effects of economic inequality in their educational journey.

Also highlighted among scholars is the incapacity or unwillingness of governments to ensure that minimum wages rise in line with inflation or to divide wealth more fairly through social spending or taxes (Smeeding 2006). Inflation applies to all citizens, and one's level in the economy is not considered. The lower-earning citizens are the hardest hit by the rise in inflation as they must make ends meet with the same income they had when inflation was lower (Lee 1999). Again, this may impact how the university student performs in their academic career and can inhibit the ease with which teaching and learning should occur when the necessary support is available. In the case study presented in this section, we demonstrate how these economic inequalities can manifest at an HEI and how they can impact the university experience of students.

In addition to the clear factors highlighted in the literature, there is a connection between social inequalities and economic inequalities. Some of the factors discussed under social inequalities also relate to economic inequalities to some extent. Economic inequalities may play out through gender differences and ethnic or cultural differences. Max Haller points out, as cited by Momin (2016), that 'ethnic heterogeneity…has a significant bearing on inequality and is often a breeding ground for economic inequality and the exclusion and exploitation of minority groups'. In these societies, the dominant ideology is that of those who hold positions of power and of those ethnic groups deemed more superior than others. This, therefore, results in social inequalities as these dominant ideologies play out and result in socio-economic disparities at higher education institutions. Literature reveals that students from different socio-economic levels do not perform the same way because of the differences in their experiences at HEIs.

Andre van Zyl (2016) undertook a study at the University of Johannesburg to explore the relationship between the socio-economic status level and other socio-demographic factors and its impact in the South African context. The purpose was to determine how students can be assisted to ensure success at the South African university. Van Zyl makes an important observation that student success is significantly influenced by factors directly associated with poverty or socio-economic level, including social capital, education and a lack of career guidance (2016). This study was carried out using a sample size of responses from 21 037 students, of which 82.1% of the sample were black African, 3.5% Indian, 3.6% mixed race and 10.8% white, which is reflective of the South African population statistics. Students were provided with a Student Profile Questionnaire between 2010 and 2015.

Some of the findings from the study showed that students from a lower socio-economic status were more likely to drop out because of various financial obstacles, such as lack of funding, which causes anxiety among the students about whether they will finish their course of study or not. Also, because these students are unfunded and cannot afford university residences, they opt to travel, which also puts financial strain on the students. Students from the middle socio-economic status were revealed to have been less worried about money. If they were not accommodated at residences, they could afford to rent communes and residences near the university, making their university experience easier than the first group. The high socio-economic status group of students was the privileged minority, who had no financial pressure and relied on their parents to fund their studies. This allowed the students to focus more on their studies and perform better at university. Overall, their university experience was better, but they did show some challenges at home. Given these findings, Van Zyl (2016, p. 11) concludes:

> [*T*]hat both poverty (and its effects) and wealth (and its effects) create very high levels of inequality in an entering cohort, as well as in their experiences of higher education.

Studies have found that students from lower socio-economic status levels are most likely to be first-generation university entrants to have attended schools that delivered poor education, and they have little financial aid in addition to other socio-cultural variables (Van Zyl 2016; Wessel et al. 2006). As much as these students may have access to higher education, the experience of this would not be the easiest. Considering that nobody in the family has been to university, it may be difficult for the family to support these students. More importantly, the family cannot assist the students with acquiring the necessary digital devices to improve their experience at the HEI.

Use of information communication technology in education

The rapid growth of ICTs has become one of the most discussed topics in the past two decades, given its profound impact on various aspects of society, particularly education. The integration of ICTs in teaching and learning has brought opportunities and challenges to students in higher education, especially for first-year students in South African universities. Information and communication technology has immense potential to equip students for life in the 21st century. By acquiring ICT skills, students become well-prepared to confront future challenges, grounded in a solid understanding (Ghavifekr & Rosdy 2015). Bransford, Brown and Cocking (2000) posit that the use of ICT contributes significantly to the development of competencies essential for navigating the currents of globalisation in the present era. Information and communication technology serves as a catalyst, empowering students to cultivate skills, enhance motivation, and broaden their scope of knowledge and information. Information and communication technology integration has led to the transformation of teaching and learning by using digital systems.

Many South African universities, including the university wherein this study was conducted, provide specialised ICT support to students from 'marginalised' families. The term 'marginalised' in this chapter refers to individuals or social groups who, based on factors such as race, gender, geographical location (including rural areas, townships or economically disadvantaged neighbourhoods), among others, have historically been positioned on the margins or periphery of the mainstream social and economic hierarchy (Cross & Atinde 2015). Marginalisation implies a systematic and often unjust exclusion or neglect of certain groups, limiting their access to resources, opportunities and societal decision-making processes. While this divide remains our premise for understanding digital inequalities, there has been a noticeable change in access and digital inclusion post-COVID-19. The post-COVID era further created ‘contextual social’ and economic inequalities (Heeks 2022). This chapter aims to highlight the silences and imbalances created by digital inequalities.

Digital technologies and inequalities

Information communication technologies and the Internet have become part of our daily lives, such as the IoT. Digital technologies, on the other hand, incorporate all technological devices, tools and systems that allow people to create, store and use data or information; this includes artificial intelligence (AI). These technologies allow us to transform some of our everyday tasks into simple digitised activities, thus digitalisation. Frenzel et al. (2021, p. 3) describe digitalisation as ‘the socio-technical conditions of the adoption and use of digital technologies’ adopted by Legner et al. (2017). A student, for example, can substitute a pen and paper for a computer or laptop when writing an assignment or project. Sometimes, a change can be significant in that it allows us to create tasks we never imagined or automate tasks that otherwise could have been time-consuming and costly. For instance, a departmental secretary can generate a report or a spreadsheet detailing students’ marks or grades based on data available on the computer. As previously discussed, digital inequalities may exist because of a lack of access to the necessary knowledge, skills and competencies to operate or use these devices or digital technologies for teaching, learning and everyday life.

Inequality is a global challenge, and this was fuelled and exposed by the outbreak of COVID-19, which deepened the pre-existing inequalities in education (UNESCO 2020). Digital divide is a multidimensional concept that has evolved over the past two decades, taking into consideration technological, socio-economic, socio-political and socio-cultural factors.

In higher education, students learn using an LMS wherein they learn at their own pace and access material anytime and anywhere. During COVID-19, many students were thrown into the deep end, and they had to swim or sink. As the lockdown period progressed, students had to stay at home, and the only way to learn was through the LMS and other alternative means accessed via mobile devices, laptops or tablets. Digital inclusion and access occurred by default. However, students in rural areas with little or no Internet connectivity suffered the most, specifically first-years new to the university. First-year students enter universities with mixed emotions: the excitement of getting the opportunity to change their situation back home and the fears of inequality as they may face various barriers and challenges in their educational journey. These challenges include adapting to new educational contexts, high expectations, difficult home environments, acculturation difficulties, and feelings of disconnectedness and exclusion.

Rural areas in South Africa are mostly previously segregated and marginalised areas, formerly known as TBVC states (Transkei, Bophuthatswana, Venda and Ciskei). These areas were reintegrated into South Africa post-democracy. However, the effects of colonialism and the apartheid system are still evident in these areas through poor infrastructure, poor connectivity, a lack of access to the Internet, a high unemployment rate, rurality and a lack of digital literacies. Many students in these areas have never used technology for learning, even though they are presumed digital immigrants (Ndebele & Mbodila 2022). While the use of the Internet in South Africa has improved from 49% in 2018 to 76% in 2022 (Partridge 2023), a survey conducted by Cowling (2023) on Internet usage by province reveals Gauteng as having the largest share of users at 42%, followed by KwaZulu-Natal and Western Cape only at 13.2% and 12.4%, respectively. The rate of Internet users in the Eastern Cape, where this study was conducted, is only 5.04% (ranked third from the bottom), followed by Northen Cape at 2.56% and Limpopo at 2.16%; these are the most rural and poorest provinces. Most students who participated in this study are from the Eastern Cape, KwaZulu Natal, Limpopo and Northern Cape (Cowling 2023).

Learning through technology is often introduced to students from rural areas only upon their entry into university. At this stage, the orientation and induction process significantly influences their readiness and willingness to embrace technology for academic success. Mbaleki, Mbodila and Dagogo (2023), in their study on determining the university readiness of first-year students and their transition from basic to higher education, highlight the importance of understanding socio-economic factors to facilitate a smooth transition of first years to university. Based on this foundation, a pilot study was conducted to assess first-year students' perceptions and experiences regarding social, economic and digital inequalities. This pilot aimed to determine student readiness for digital learning and to design targeted intervention programmes that would enhance their ability to learn using digital technologies and the LMS.

Factors that may hinder the achievement of equity of outcomes according to the data from the case study

A pilot study was conducted to support the secondary data used in the first segment of this chapter. This pilot aimed to validate the findings by examining first-year students' perceptions and experiences related to social, economic and digital inequalities. The results of this investigation are tabulated in Table 3.1 and Table 3.2 offering a clear and detailed overview of the primary data collected, which complements the secondary data and strengthens the overall conclusions drawn from the research.

Navigating digital inequality through the lens of late adoption

Examining digital inequality from the perspective of late adoption in research uncovers a complicated web of interrelated causes. Hsieh and Arun Rai (2008) and Asmar et al. (2022) both highlight the role of socio-economic constraints, with Hsieh and Arun Rai (2008) emphasising the impact of personal network exposure and enjoyment, and Asmar et al. (2022) presenting a model that combines social and digital indicators. As already mentioned, first-year students must deal with the transition of coming to university, an entirely new environment. When they encounter technology for the first time at university, they must also deal with the

TABLE 3.1: Survey questions and responses.

Survey question	Yes	No
Did you learn using technology prior to coming to university?	35.6%	64.4%
Did you have access to Internet?	29.9%	70.1%
Did you own a laptop?	5.0%	95%
Did you own a smartphone?	59.1%	40.9%
Are you funded by the National Student Financial Aid Scheme (NSFAS)?	99.0%	0.01%
Are you a first-generation student?	90%	10%

Source: Walter Sisulu University Student Academic Readiness Survey (STARS), 2022/23 (Unpublished).

TABLE 3.2: Digital literacy skills upon entry at university.

Rate your digital skills knowledge before the course	Count	Percentage
Extremely knowledgeable	63	0.7
Moderately knowledgeable	1168	13.1
Not knowledgeable at all	1350	15.1
Slightly knowledgeable	1645	18.4
Very knowledgeable	235	2.6
Grand total	**4461**	**49.9%**

Source: Authors' own work.

anxiety that comes with learning how to use technology. This anxiety could potentially lead to poor academic performance.

In the study conducted at the HBU, of the 7200 first-year students who took the survey, 64.4% indicated that they had not learnt to use technology before coming to university. Then, 70.1% indicated that they had no access to the Internet before coming to university. Considering these findings, students who adopted the use of technology later than others meant these students had to first focus on learning how to use technology tools that would assist in teaching and learning. This meant their focus was already divided from the beginning as they had to learn how to navigate their way around technology before starting to grapple with the content they were to learn. Late adoption of technology, therefore, disadvantages the student. Considering that National Student Financial Aid Scheme (NSFAS) funds 99% of these students, it tells us that they are from lower socio-economic status.

Adaptation struggle

Digital inequality presents a significant challenge for first-year students, particularly those from rural areas or with limited prior exposure to technology (Faloye 2021; Oyedemi & Mogano 2018). This can lead to difficulties in using application programmes, downloading materials and navigating the Internet (Faloye 2021). The lack of access to technology before university can also impact academic performance, particularly in information technology (IT) courses (Ngarandi, Faniran & Ajayi 2017). To address these challenges, initiatives to provide educators with access to technology and digital literacy are crucial (Oyedemi & Mogano 2018). Additionally, adaptation training for first-year students can help them navigate the university environment.

Language anxiety

Language anxiety typically refers to the feeling of uneasiness or apprehension that individuals may experience when using a foreign language or communicating in situations where a specific language is required. In the context of students entering educational environments with digital inequalities, language anxiety can be inflamed by the unfamiliarity or discomfort associated with using technology for learning. Digital inequalities can manifest in various ways, such as disparities in access to devices, Internet connectivity and proficiency in digital skills. In many cases, applications used to enhance learning and teaching are designed to use one language, so if students are not familiar with the language, this becomes a challenge or demotivation for them to use technology.

Access to technology

Kapusta and Shorter (2019) discuss how the digital inequalities in the K-12 sector influence the student's success prior to entering university and how access and use of educational technology impact students of different socio-economic backgrounds; this emphasises the direct correlation between these digital inequities and students' academic preparation for higher education. One key aspect discussed by the authors is how these digital inequalities contribute to variations in academic preparedness among students from different socio-economic backgrounds. Students with limited access to educational technology may miss opportunities for interactive and personalised learning experiences. The gap in exposure to digital tools may affect their digital literacy skills, hindering their ability to effectively engage with online resources and collaborative platforms. The impact elicited by the structural and cultural conditions in which students find themselves may create a feeling of alienation, inequality, doubt, and isolation or loss of identity. The findings from the study on first-year students in a South African higher education institution highlight significant challenges related to technology use and access, which resonate with broader discussions on digital equity and the integration of technology in learning environments. Only 35.6% of students reported having learnt to use technology before entering university, indicating a substantial gap in technological exposure prior to higher education.

According to the 2012 report by the Organisation for Economic Cooperation and Development (OECD) on equity and quality in education, high-performing education systems combine equity with quality, giving students equal opportunities for good, quality education (OECD 2012). The institution where the study took place has made efforts to ensure that both students and educators have access to broadband Internet and efficient wireless connectivity, specifically promoting equitable access beyond the school environment. The Office of Educational Technology in the United States published a national education technology plan update; in this plan, they highlighted a strategy for using technology to enable and improve learning at all levels, in all places and for people of all backgrounds. In this strategy, they acknowledged that technology may not necessarily guarantee equity and accessibility to learning. Still, it brings high possibilities of reducing barriers to equity and accessibility in previously impossible ways (Office of Educational Technology 2017). This inclusivity of learners from all levels of study responds to what this chapter highlights, closing the gap in technology access for learners before entering university.

Lack of digital literacy skills

When students were asked to rate their digital literacy skills, 18.4% indicated slightly knowledgeable, while 15.1% indicated not knowledgeable, as indicated in Table 3.2.

As the institution strives to empower students with the tools necessary for success, understanding the baseline digital proficiency of learners is a crucial first step. The data presented herein offer insights into the self-perceived digital skills of participants to establish who should be engaging in a digital skills course the institution offers for first-years. The self-assessment data reveals a diverse distribution of participants across various levels of digital knowledge. The largest cohorts rated themselves as either 'Slightly Knowledgeable' or 'Moderately Knowledgeable', comprising 18.4% and 13.1% of the respondents, respectively. A noteworthy proportion of participants, 15.1%, admitted to being 'Not Knowledgeable at All', indicating a potential gap in foundational digital skills. Conversely, only a fraction of individuals considered themselves 'Extremely Knowledgeable' (0.7%) or 'Very Knowledgeable' (2.6%). These findings suggest a refined landscape of digital literacy among participants, emphasising the need for tailored digital skills training. The higher prevalence of participants in the middle range of self-assessment implies a widespread recognition of the importance of digital skills but a realisation that improvement is needed. Moreover, the substantial percentage of participants acknowledging a lack of knowledge underscores the critical role of the impending digital skills course.

When students were asked to share 'their experiences of digital inequalities', it became evident that cases of 'digital divide' were more prevalent. Students indicated varying opinions ranging from not having a cellular phone, as evidenced through the quantitative data, to the experience of struggling to apply to university for admission and anxiety of not knowing what to expect when they reach university because of 'everything digital' citing 'online application'. One of the respondents remembers having to ask for a university student to apply for her with his phone. Upon getting a cell phone, tracking the application became difficult because a different cell phone number was used during the application. Therefore, a conclusion can be drawn that digital inequalities may occur because of social inequality and varying socio-economic backgrounds. These inequalities have the potential to create anxiety, feelings of helplessness and a lack of identity for students coming from rural areas. The project sought to pave the way for a more equitable educational experience for all students and thus reduce disparities inflamed by the inequalities.

First-generation students

Mbaleki et al. (2023) indicate intergenerational payoffs associated with being a student from an educated background as having a better chance to succeed. Although this may not always be the case, first-generation students are assumed to be 'at risk' of failing, especially in their first year. The findings of the study indicate that at least 90.0% of students who participated are first-generation students. The university established a student tracking unit to identify students who are 'at risk' as soon as the first assessment results are known.

Recommendations

The following strategies are recommended: creating a more inclusive and digitally equitable environment for first-year students to thrive, strengthening frameworks for inclusive education, community awareness and engagement, resource provisioning and institutional support, establishing partnerships and increasing collaborations with industry, and improving teacher capacity to address diverse learning needs and finally, the implementation of sustainable technological solutions. Further studies may focus on the impact of digital inequalities on students living with disabilities. This chapter recommends the recognition of existing cultural and structural systems so that all students can participate as equals in higher education and thus bridge the digital inequality gap.

As proposed by Oyedemi and Mogano (2018), a crucial point on the agenda should be the provision of computers and Internet connections. The initiative involves supplying all students with laptops and ensuring ongoing access to devices beyond school hours. However, it is emphasised that the mere provision of technologies does not inherently translate to skills acquisition. The important factor lies in integrating technology into the curriculum and offering comprehensive training to lecturers. This concerted effort not only affords students the chance to enhance their skills and achieve academic success but also prepares them for the challenges of the real world upon graduation.

Conclusion

The results in this chapter further reveal and emphasise social and economic inequalities as some of the key contributors to digital inequalities in higher education, particularly among first-year students. As already highlighted in the chapter, most first-year students in the institution where the survey was conducted were first-generation students and were NSFAS-funded. Already, these students were at a disadvantage in terms of digital technologies when they arrived at university. Of the large number of students who were surveyed and discovered to be first-generation students and NSFAS funded, only a sum of them encountered learning with technology upon arrival at university.

The government, along with higher education institutions and industry partners, has made attempts to reduce the burden of social and economic inequalities on students. Blade Nzimande, the former Minister of Higher Education, Science and Innovation in South Africa, launched an initiative aimed at narrowing the digital divide among university students. This initiative involves the distribution of laptops, funded through the NSFAS, along with data to ensure that students have the tools for online learning (Media Statement 2020). This has been ongoing since 2020, and that is how first time entrants (FTENs) from disadvantaged communities get access to laptops and data in the institution where this study was conducted. Other initiatives include internal processes in which students can purchase laptops from the university. Students are also provided with monthly data, and agreements are made with industry partners to ensure that the sites frequently accessed by students are zero-rated. The offered support service includes technical help desks that students can use when they have laptops and connectivity issues.

Social, economic and digital inequalities are a global phenomenon. It can be argued that the impact of colonialism in African states and the apartheid system in South Africa contributed largely to the socio-cultural and socio-economic inequalities that continue to widen the digital divide. First-year university students encounter challenges such as unfamiliarity with the technologies employed and a deficiency in basic computer skills (Faloye & Ajayi 2021). Addressing these challenges, the institution provides support during the initial orientation week. Termed ‘Digital Week’, this dedicated period acquaints students with the technological tools for learning. They receive training on accessing these tools and receive assistance in creating their accounts. The next chapter discusses how digital inequalities also affect teachers in skills development and service delivery.

Chapter 4

Digital inequalities' impact on pre-service teachers in South African universities

Ntsika Dyantyi
Department of Business Management Education,
Faculty of Education, Walter Sisulu University,
Mthatha, South Africa

Bulelwa Mkabile-Masebe
Department of Business Management Education,
Faculty of Education, Walter Sisulu University,
Mthatha, South Africa

Abstract

Digital inequalities persistently affect educational systems, posing challenges to the development of 21st-century skills among pre-service teachers. This research delves into the nuanced relationship between digital disparities and the preparedness of pre-service teachers to navigate the demands of the 21st-century classroom. Drawing on a qualitative case study research design, data were gathered through semi-structured face-to-face interviews. A narrative analysis was employed to analyse data. The main results revealed that most of the sampled level four pre-service teachers do not feel competent in integrating information and communication technology (ICT) into their teaching. The students attributed this inadequate training and support by the university during their study period. In conclusion, this chapter recommends the development

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of ICT courses or modules from levels I to III aimed at enhancing pre-service teachers' capacity to integrate digital technologies into the classroom. This preparation will ensure that graduates are ready to incorporate ICT into their pedagogical practices. This aligns with the vision of Agenda 2063, which emphasises the integration of modern technology in education to foster a more competent, innovative and digitally literate workforce capable of driving Africa's development forward.

Introduction

Digital inequalities manifest in various forms, encompassing social, economic and digital aspects, as presented in Chapter 3. This chapter provides a specific example of the inequalities faced by rural teachers. Digital inequalities present a significant challenge to the development of 21st-century skills among pre-service teachers, impacting their readiness for the evolving educational landscape. Despite the growing emphasis on integrating technology into education, disparities in access, digital literacy and exposure persist among pre-service teachers. This chapter aims to investigate the nuanced ways digital inequalities hinder the acquisition of essential 21st-century skills during the pre-service teacher training phase, thereby affecting their overall preparedness for effective teaching in modern classrooms. Technology integration has become pervasive in the modern education environment worldwide. However, pre-service teachers' preparedness to effectively incorporate technology into their teaching through ICT continues to be a significant concern. According to Finger, Jamieson-Proctor and Albion (2010), the quality of the teacher is a crucial determinant of student success. Teachers with a deep understanding of their subject matter and the pedagogical skills to effectively convey this knowledge are better equipped to foster student learning. Their expertise allows them to create engaging and comprehensible lessons that cater to diverse learning needs. Pre-service teachers are a generation that actively uses ICT for educational purposes and daily living (Tapscott 2018). Teachers utilise digital tools and resources to develop interactive and engaging learning experiences for their students. This involves employing online platforms for collaboration, digital simulations for hands-on learning and multimedia content to enhance lessons. The successful integration of technology into teaching and learning largely depends on the teachers' role. Despite the ease of integrating components like technological infrastructure and addressing legal and administrative issues, teachers are the key implementers, and their relevant capacity and performance directly influence success. Hence, it is essential to equip teachers with the skills to use technology in teaching, starting from the pre-service stage.

Demirli (2013) argues that despite significant investments in ICT, the effective use of these technologies remains low. This issue arises because the teaching and learning process often concentrates only on the pedagogic context, overlooking the ongoing advancements in technology integration. Consequently, more effective results could be achieved through well-planned applications of integration components, including technical infrastructure, pre-service teacher training, effective leadership and vision. Technology integration involves more than just incorporating it into the classroom. Teacher education institutions (TEIs) need to help pre-service teachers develop technical skills, pedagogical practices and subject knowledge, understanding how these elements interrelate and complement each other to prepare them for effective technology integration (Graham 2011; Koehler & Mishra 2009). The concept of technological pedagogical content knowledge (TPACK), introduced by Mishra and Koehler (2006), provides a theoretical framework for understanding the knowledge teachers need to integrate technology successfully. For a detailed explanation and history of TPACK, refer to earlier works by Harris, Mishra and Koehler (2009), Mishra and Koehler (2006, 2007) and Voogt et al. (2013). Achieving effective technology integration in teaching processes is a significant challenge in teacher education. It is observed that in many technology integration initiatives, the dimension of teacher education is not prioritised. Consequently, graduate pre-service teachers are often trained only in the job-related use of technology.

It is noted that many technology integration initiatives do not prioritise the aspect of teacher education. As a result, newly graduated pre-service teachers are frequently trained solely in the job-related use of technology. Pre-service teachers often lack competence in using technological tools for teaching, even though their academic programmes include a year-long study of computer applications in technology from level one to exit level. Cuhadar (2018) suggests that to enable teachers to use technology effectively in instruction, pre-service teacher education programmes should offer extensive practical experiences, allowing them to plan, teach and reflect on technology-enhanced teaching. This method can enhance pre-service teachers' confidence and foundation in using technology to assist learners who might find it daunting. Teacher training programmes require systematic strategies and practices to prepare teachers for effective technology use in their classrooms. Hlobo, Moloi and Mhlanga (2021) highlight that pre-service teachers in Pakistani universities need more computer skills for technology integration in the classroom. The pace of technological innovation in education necessitates that teachers continually update their computer skills. Pre-service teachers must be proficient in using various digital tools, software and platforms to create engaging and effective learning experiences. Hlobo et al. (2021) argue that technological advancements in schools are transforming the educational paradigm.

To boost learners' skills, the teacher's role needs to evolve from simply delivering content to actively guiding knowledge creation. Educators are now required to craft learning experiences that incorporate technology across the curriculum, promote critical thinking and take on leadership roles in the educational process.

According to Mwapwele et al. (2019), half of the South African teachers expressed unease about using technology to teach, troubleshooting technical issues and lacking the requisite personal technological skills. To fulfil the demands of the 21st century, individuals require more than just core subject knowledge. Mncube, Olawale and Hendricks (2019) posits that the South African education system needs an ICT-literate society to compete globally. This means that educational institutions need to focus on developing students' proficiency with ICT. An ICT-literate society is one where individuals are skilled in using digital technologies, which is crucial for participating in and contributing to the modern global economy. This emphasis on ICT literacy will enable students to be competitive in a technology-driven world, fostering innovation and improving the nation's position in the global arena. Individuals must apply their knowledge and skills by thinking critically, utilising knowledge in new contexts, analysing information, generating new ideas, communicating effectively, collaborating with others, solving problems and making decisions (Singh & Chan 2014). This involves critical thinking, where they assess and interpret information deeply and the ability to adapt their knowledge to new and diverse situations. Additionally, they need to analyse data, develop innovative ideas and communicate their thoughts clearly. Collaboration with others is essential for sharing insights and working towards common goals. Given this background, the chapter evaluates pre-service teachers' preparedness for 21st-century skills development in one South African university.

Research question

The research question that guided the chapter is:

> How do digital inequalities impact the preparedness of pre-service teachers for 21st-century skills development in one South African university?

Literature review

Empirical literature

Teaching in the 21st century has advanced considerably, necessitating that teachers integrate technology into their lessons to align with contemporary literacy standards (Mncube et al. 2019). As a result, pre-service teachers must incorporate technology into their teaching practices from the outset of their careers. Cuhadar (2018) highlights that while teachers generally have a favourable attitude towards using technology in the classroom, insufficient vocational training continues to pose a challenge. This means that despite their enthusiasm and willingness to incorporate technology into their teaching, teachers often lack the necessary skills and training to use these technological tools effectively. The gap between their positive attitudes and their ability to integrate technology highlights a critical barrier: without proper and comprehensive training, teachers cannot translate their positive attitudes into effective technology use in their educational practices.

Evaluations of the Turkish educational system have revealed that teacher education programmes often fail to adequately prepare teachers to integrate technology into education (Canbazoglu, Guzey & Yamak 2016). This situation creates a recurring issue where pre-service teachers receive inadequate training in technology use for teaching and must then gain the necessary knowledge, skills and experience during their education. Research shows that pre-service teachers frequently lack confidence in using technology effectively in the classroom and often do not incorporate technology into innovative teaching strategies (Tondeur et al. 2017). The United States Department of Education highlights that pre-service teachers need multiple meaningful experiences to develop the beliefs and knowledge required for effective technology integration in teaching (Higgins, Li & Deeks 2019). Pre-service teachers embrace technologies and activities they find natural or easy to use in their teaching. Butler-Adam (2018) found that pre-service teachers were not proficient in basic computer operations or generic software, and their perceptions of digital technologies were not positive when they observed specific technologies being used effectively. This suggests that although pre-service teachers may understand the benefits of technology, their limited practical experience and training undermine their confidence and effectiveness in using these tools. As a result, their views on technology remain sceptical, which can impact their willingness and readiness to integrate digital tools into their teaching practices.

Similarly, in Turkey, Harris and Hofer (2011) found that pre-service teachers were hesitant to incorporate technology into their teaching because of a lack of technical resources and insufficient instructional training. As computers were first introduced in schools, preparing pre-service teachers in technology has been challenging. Although computer labs were set up in teacher education colleges to provide technical skills, these skills alone did not lead to effective classroom integration. Stand-alone technology courses can be pivotal in teacher preparation by promoting a 21st-century mindset and offering a stronger rationale for using technology in teaching.

Pre-service teachers have the potential to leverage technology to enhance higher-order thinking skills, as outlined by Bloom's Taxonomy. Demirli (2013) highlights the importance of initial technology courses in developing teachers' technology proficiency. These courses often include collaborative projects that mirror real-world teaching scenarios, helping pre-service teachers develop essential teamwork and problem-solving skills. In the South African context, Mlotshwa, Tunjera and Chigona (2020) found that many pre-service teachers felt inadequately prepared and lacked the necessary resources to teach with technology in South African schools effectively. Limited access to technological resources in training institutions restricts opportunities for pre-service teachers to familiarise themselves with the tools and platforms they will need in the classroom. Moloi and Mhlanga (2021) argue that teachers in rural schools often do not value adopting new technologies because of a lack of formal training. This situation poses challenges for schools attempting to transition to the Fourth Industrial Revolution (4IR) because many in-service teachers struggle to use even basic technology tools effectively. The insufficient preparation and training of pre-service teachers in technology contribute to widening the digital divide between affluent and historically disadvantaged schools in South Africa.

The Department of Higher Education and Training (DHET) introduced the Minimum Requirements for Teacher Education Qualifications (MRTEQ) policy, which outlines guidelines for TEIs to develop their programmes and curricula. Minimum Requirements for Teacher Education Qualifications emphasise that a teacher's ability to use ICT for innovative teaching and learning is crucial. However, the policy also mandates that if a teacher enters their programme without ICT competency, higher education institutions should enhance the trainee teacher's confidence and skills in ICT (DHET 2015). Despite this policy, Moloi and Mhlanga (2021) contend that the South African government needs to focus on acquiring technologies to support and enhance teaching and learning in the 4IR era. Today's students are digital natives, having grown up in an era of technological development, and regularly use platforms such as Facebook, Instagram, LinkedIn and Twitter for communication and entertainment (Swanepoel & Bruwer 2020). Many young people increasingly use digital gadgets for work, education and leisure activities (Woo, White & Lai 2016). Teacher Education Institutions need to prepare pre-service teachers to effectively use technology to ensure that students are equipped for success in the technologically advanced 4IR (Mwapwele et al. 2019). In response, the South African government has implemented ICT policies such as the MRTEQ, which mandate that TEIs create environments that enhance pre-service teachers' technological proficiency to improve teaching and learning (Umugiraneza, Bansilal & North 2018). This supports Sabiri's (2020) view that effective technology use in curriculum delivery greatly benefits students. To ensure that learners become global citizens in a complex and evolving world, 21st-century teachers must be knowledgeable about and engaged with the 4IR.

A preliminary review of the literature indicates a lack of research on the 4IR's impact on education in developing countries, particularly South Africa (Butler-Adam 2018; Henama & Sifolo 2021; Hlobo et al. 2021; Moloi & Mhlanga 2021; Ogunlela & Tengeh 2021). To thrive in the 4IR era, high levels of numeracy, literacy and a comprehensive understanding of global operations are essential (Butler-Adam 2018). Reflecting this need, the South African Minister of Basic Education announced the introduction of three new subjects – Robotics, Coding and Kiswahili – to be piloted in 1000 schools across five provinces in 2020 (Moloi & Mhlanga 2021). Pre-service teachers should be re-skilled in utilising technology in diverse ways (Waghid 2019). However, South Africa's readiness for 4IR technologies remains uncertain (Olaitan, Issah & Wayi 2021), as many developing countries still struggle with inadequate infrastructure, poor connectivity and unreliable Internet (Adesote & Fatoki 2013). Addressing these inadequacies and the lack of proper technology infrastructure is crucial for policy implementation. The reviewed literature suggests that, nationally and locally, insufficient efforts have been made to address pre-service teachers' preparedness for 21st-century skills development at one South African university.

Theoretical framework

Mishra and Koehler (2006, 2009) created the TPACK framework, which forms the basis of this chapter. The TPACK framework is designed to evaluate the different types of knowledge teachers need to effectively incorporate technology into the complex and varied nature of teaching. According to Harris and Hofer (2011), TPACK is a unique type of knowledge that helps integrate technology with content-focused teaching. This framework extends basic knowledge from teacher education, emphasising the understanding educators need to analyse and enhance their teaching methods. It highlights the interaction among three key areas: technology, pedagogy and content, which defines the essential qualities of teacher knowledge necessary for effective technology integration (Koehler & Mishra 2009; Mishra & Koehle 2006). Technological Pedagogical Content Knowledge emphasises that successful technology integration involves not merely adding technology to existing teaching and content but also thoughtfully using domain-specific knowledge with suitable technologies to enhance teaching (Niess 2011). Schmidt et al. (2009) found TPACK to be a valuable tool for identifying the knowledge pre-service teachers need to develop. Since its inception, TPACK has been used to assess teachers' knowledge and the need for effective technology integration in their teaching (Koehler & Mishra 2009). Schmidt et al. (2009) propose that applying TPACK as a framework could influence the design of training and professional development for both pre-service and in-service teachers. The framework has been applied in various fields, including science (Handal et al. 2013), geography (Su et al. 2017) and mathematics (Canbazoglu et al. 2016). It has also been used to analyse the knowledge bases of pre-service teachers (Baser, Kopcha & Ozden 2016).

Technological pedagogical content knowledge facilitates the integration of technology with pedagogy and content to optimise students' learning potential. Research shows that many teachers struggle to effectively combine pedagogical and subject matter knowledge (Parker 2009; Swanepoel 2009). Mishra and Koehler (2006) suggest that integrating ICT into pedagogy can improve teaching by offering consistent and flexible knowledge empowerment. The TPACK framework underscores the importance of a balanced approach to technology integration, particularly relevant in the face of digital inequalities. It helps illuminate how technology access and training gaps can affect pre-service teachers' ability to develop and apply 21st-century skills effectively. For pre-service teachers in a South African university, addressing digital inequalities through a TPACK-informed approach can lead to more equitable and effective teacher preparation. Providing all pre-service teachers with the essential resources and training to incorporate technology into their teaching will help close the gap and improve their readiness for contemporary teaching challenges. Insights gained from applying the TPACK framework can inform policy and practice by highlighting the need for targeted interventions to address digital inequalities. This might include enhancing infrastructure, providing equitable access to resources and designing professional development programmes that address the specific needs of pre-service teachers in digitally underserved contexts. This theory suggests that in-service and pre-service teachers should align their technological, pedagogical and content knowledge, making it particularly relevant for this chapter, which aims to assess pre-service teachers' preparedness for developing 21st-century skills at a South African university.

Methodology

This section discusses the methodology used in this chapter. It explains the research design, population and sampling procedure, data collection methods, ethical considerations and data analysis procedures.

Research paradigm and approach

The chapter used a qualitative research methodology within the interpretative paradigm, guided by constructivist theory (Cherry 2020). This theory posits that individuals construct their own understanding of the world and use these perspectives to interpret their experiences and observations. The interpretivist paradigm was selected because it investigates how people assign meaning to their surroundings and how their perceptions of reality influence their interpretations (Maree 2019). Interpretivism aims to uncover the underlying meanings that drive human behaviour. According to Henning et al. (2004), a qualitative research approach facilitates the natural and unrestricted emergence of themes, as it generally avoids altering the parameters under this chapter.

Research design and participants

Using a case study research approach, the chapter concentrated on a small number of individuals. To capture the actual context of an occurrence, case study research aims to gain a deep understanding of a situation (Cohen et al. 2011; Kumar, Cohen & HomChaudhuri 2011). This chapter was thought to be a good fit for a case study because participants were observed in their natural environments to understand the present issue, and the researcher concentrated on a small sample of participants to ensure accuracy and a thorough knowledge of the pre-service teachers' preparedness for 21st-century skills development in one South African university. A total of four participants were purposively selected. These participants were selected because they were anticipated to possess the potential information to address the research objectives. The participants for this chapter were final-year students registered for a Bachelor of Education degree in one South African university.

Method of data collection

Semi-structured interviews with the participants were used to gather information. It is imperative to apply this methodology because it provides an adaptable and flexible framework that allows participants to express their ideas, opinions and experiences (Whiting 2008). The ability of the participants to collaborate with the researcher through this method leads to a deeper understanding of the subject matter from multiple perspectives. One way to guarantee that more complete and accurate data are collected during semi-structured interviews is by using follow-up questions to expand on or clarify the participants' remarks (Adams 2015). Because semi-structured interviews enhance the quality and validity of the data collected, their inclusion in this chapter was relevant.

Method of data analysis

A narrative analysis was used to analyse the data. According to Baker (2019), a technique called narrative analysis is utilised to analyse and comprehend the stories that individuals tell. It is a method of learning about people, civilisations and society by examining the structures and patterns found in these tales. The author claims that a narrative analysis can be used with various materials, including social media posts, interviews, movies and written or spoken tales. For this chapter, using a narrative analysis provided a deep understanding of the pre-service teacher's preparedness for the 21st-century skills development in one South African university.

Ethical considerations

To safeguard the rights and welfare of research participants, Maree (2019) highlights that researchers have ethical obligations, including following legal requirements during data collection and reporting. In this chapter, informed consent was obtained from all participants, ensuring they were fully informed about the chapter's goals, methods, potential risks and benefits, and other relevant information. Participants were also free to withdraw from the study at any time and encouraged to ask questions. These steps were taken to protect participant rights and adhere to ethical research practices. Furthermore, participants were anonymised and identified as S1, S2, S3 and S4 to ensure their confidentiality.

Discussion of results

The chapter results revealed that pre-service teachers in the university do not have adequate foundational competencies in the use of technology, including digital literacy skills, making it difficult for them to integrate technology into their lessons. Mncube et al. (2019) posit that the South African education system needs an ICT-literate society to compete with the rest of the world. Pre-service teachers need to be capacitated on how to use technological tools in education so that they can meet the demands or needs of the 21st century:

> S1: 'Many of us feel that we do not have adequate knowledge of the basic foundation of computer literacy; hence it is difficult for us to use technological tools in our lessons. At times, we do not even understand the technological terminology.'

> S2: 'Really, I am not ready to integrate technology in teaching due to the fact that there is no proper training provided by the university with regards to the use of ICT or technology in the teaching and learning process.'

Pre-service teachers who participated in the study indicated under-preparedness and inability to use ICTs during teaching practice in their third year of study. They indicated that they lacked confidence and felt that they did not possess the required technological knowledge to help them integrate digital technologies into teaching and learning effectively. This aligns with findings from Tondeur (2017), who observed that pre-service teachers at their university felt unprepared to incorporate technology into their teaching and did not employ innovative technological strategies. This lack of preparedness is reflected in their reluctance or inability to use technology in innovative ways. Essentially, the study found that these pre-service teachers felt uncertain about how to incorporate technology into their lessons effectively and did not utilise technological tools to enhance or transform their teaching methods. This suggests a gap in their training or confidence regarding the use of technology, which could impact their future effectiveness as educators in a digital age. This is later supported by Chigona (2018), who noted that many pre-service teachers in South Africa feel inadequately prepared and equipped to utilise technology effectively in local schools. This sense of being unprepared suggests a systemic issue within teacher training programmes, where pre-service teachers might not be receiving sufficient training or resources to incorporate technology into their lessons effectively. Consequently, this lack of preparation could hinder their ability to leverage technology to enhance teaching and learning in South African schools. Mwapwele et al. (2019) further highlight that many teachers in South Africa are apprehensive about using technology in their teaching, struggle with technical troubleshooting and lack essential personal tech skills. As future educators, pre-service teachers are crucial to advancing technology use in schools. Through the use of technology for teaching and learning, these teachers have the potential to foster learning opportunities and, therefore, the ability to respond to the existing digital inequalities quite early in learners' schooling journey. Building capacity and skills in digital literacy for pre-service teachers boosts their confidence in seamlessly integrating technology, which, in turn, helps them develop essential 21st-century skills, such as creativity and innovation, critical thinking and problem-solving, communication and collaboration, in their students once they enter the field.

One clear reason for pre-service teachers' hesitancy is their lack of experience and training opportunities. Evaluations within the Turkish educational system support this view, revealing that teacher education programmes often fail to equip pre-service teachers with practical knowledge on integrating technology into education (Canbazoglu et al. 2016). This highlights the need to overhaul the content and pedagogical knowledge provided to pre-service teachers to better align with the evolving demands of education and society. In the era of digital transformation, it is essential for curriculum development in teacher training programmes to allocate sufficient time to developing technological content knowledge (TCK) and technological pedagogical knowledge, as outlined by the TPACK framework (Mishra & Koehler 2006, 2009). Pre-service teachers should be given ample opportunities to gain these experiences before beginning their teaching practice. Mishra and Koehler (2006) argue that integrating ICT into pedagogy can enhance teaching effectiveness by fostering stable and adaptable knowledge, raising teaching standards and better supporting student learning (Parker 2009; Swanepoel 2009). This integration promotes the development of stable and adaptable knowledge, which means that teachers can adjust their teaching strategies and content delivery based on students' needs and emerging technologies:

> S3: 'We lack technological skills because there is no proper access to the use of technological facilities. There is no sufficient infrastructure in our faculty; we are three departments sharing two computer labs that have thirty desktops each.'

Pre-service teachers reported a lack of technological skills because of inadequate access to technological facilities. They noted that the insufficient infrastructure prevented them from fully utilising technology for teaching and learning. This conclusion aligns with Butler-Adam's (2018) study, which found that pre-service teachers in Turkish universities were hesitant to integrate technology into their teaching because of limited technical resources. He discovered that pre-service teachers lacked basic computer skills and could not use general software. To prepare pre-service teachers with the necessary skills, attitudes and expertise for effective technology use in the classroom, they require diverse and enriching experiences. Education faculties may need to provide pre-service teachers with exposure to digital tools and knowledge essential for teaching in a digitised, smart classroom environment:

> S4: 'There was no ICT in my school. I did not struggle because I used what we used to do in class. Our curriculum is not technologically-infused; therefore, we are not competent enough to infuse technology during teaching.'

The chapter's conclusions further revealed high levels of inequalities in schools as evidenced by a lack of resources and learning and teaching infrastructures. The levels of inequalities experienced by students in rural, under-resourced schools permeate beyond just technological inequalities and may include sociocultural and socioeconomic inequalities. Pre-service teachers may find themselves in decontextualised environments when opportunities to teach using technology were previously provided. However, it is recommended that pre-service teachers be exposed to various scenarios in anticipation of potential technology failures. This can be achieved through modelling, scaffolding, demonstrations, role plays and other methods suitable for specific subjects.

Technological advancements can disrupt traditional practices and even cause discomfort among university lecturers. These changes could challenge existing beliefs, orientations and disciplinary cultures, potentially affecting the learning experiences of pre-service teachers who may not fully benefit from their instructors and mentors. Hlobo et al. (2021) argue that technological advancements in schools drive a shift in the educational paradigm, requiring teachers to design learning experiences that integrate technology throughout the curriculum. This aligns with the South African Department of Science and Technology's goal to foster innovation and technological progress, ensuring that higher education students develop the 21st-century skills essential for future success (Department of Science and Technology 2019). These skills are vital for thriving in a rapidly changing, technology-driven world. Thus, incorporating technology into teacher training supports this national objective by preparing educators to better equip their students with the competencies needed for future achievement.

For pre-service teachers, acquiring and developing ICT skills during their university studies is essential. In today's digital era, integrating technology into education is crucial, and teachers must be proficient in using ICT tools to enhance classroom instruction. Information and communication technology tools offer diverse teaching methods and resources, such as multimedia, interactive presentations, simulations and educational software, which cater to various learning styles. Collaboration with academic support departments and e-learning centres can facilitate this integration. Gaining ICT skills early in their training provides pre-service teachers with a strong foundation for ongoing professional development, enabling them to stay current with emerging technologies and continuously improve their teaching practices throughout their careers.

Recommendations for future studies

Addressing digital inequalities in 21st-century skills development among pre-service teachers is crucial for creating an inclusive and equitable educational environment. Building on the chapter focused on pre-service teachers' preparedness at a South African university, further studies could investigate the role of socioeconomic factors in digital inequalities. Specifically, researchers could examine how factors such as income, access to technology and urban-rural divides impact pre-service teachers' readiness for 21st-century skills. By addressing these aspects in future studies, researchers can contribute valuable insights to ongoing efforts to bridge digital divides and enhance the 21st-century skills development of pre-service teachers in South Africa and beyond.

Conclusion

As technology continues to advance, classrooms are becoming more digital. Pre-service teachers need to be familiar with various educational technologies, learning management systems and collaborative tools that can facilitate effective teaching and learning in a digital environment. Opportunities need to be provided for pre-service teachers to apply technology in real classroom settings. During their training, pre-service teachers should experience diverse contexts that mirror real-world challenges, such as inequalities, disadvantaged environments and limitations related to school cultures, administrative issues and access to technological resources. This exposure helps them build confidence in using technology by developing practical strategies to address potential challenges they may face in their future careers. Professional development for pre-service teachers should be designed to support their teaching and learning needs in a way that aligns with their preferences. Faculties may also seek assistance from academic support departments to address issues such as large class sizes or the need for specialised skills. Technological illiteracy is a reality for many pre-service teachers coming from rural schools. Technology is here to stay; it is imperative that the capacity to use technology meaningfully and purposefully is created for pre-service teachers. It can be argued that if a strong foundation is created early in their years at university, and nurtured as they progress through the years of study, pre-service teachers can develop a positive attitude towards adopting technology in future practices. This chapter suggests that reducing digital inequalities in teacher education is possible. However, it must be intentional and integrated progressively into the qualification over the years that pre-service teachers spend in a university. Proper infrastructure, such as micro-teaching labs and practicum rooms, must be provided where opportunities will be afforded to pre-service teachers to practise before they go out to the field.

Lastly, as a matter of fact, university teachers must try to incorporate digital tools into their teaching methods as a way of modelling and scaffolding. Role plays may be a very important instrument for pre-service teachers to demonstrate the acquired skill of using technology for teaching and learning. Higher education institutions across the globe continue to explore possibilities offered by e-learning in a globalised knowledge economy, increasingly pervasive digital, networked world, where e-learning possibilities are endless as innovations emerge. Instead of using a teaching strategy that heavily relies on physical infrastructure such as schools, tangible learning materials and in-class instruction, teachers in South African schools should switch to one that makes considerable use of interactive education technology. The next chapter expands on digital inequalities in education and outlines a path forward.

Chapter 5

Navigating digital inequality in African higher education: Challenges and charting a path forward

Sithandiwe Twetwa-Dube
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Nosipho C Mavuso
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Olukayode Oki
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Abstract

Digital inequality in education refers to disparities in access to and effective use of digital technologies by students and teachers. This inequality has worsened with the increasing integration of technology in education. Essential online learning tools, such as smartphones, tablets and personal

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computers, are often inaccessible to many students because of a lack of funding or inadequate technology infrastructure. Reliable and fast Internet access is crucial for participating in online courses, accessing learning materials, and completing assignments; however, rural learners often suffer from poor connectivity. Additionally, the cost of maintaining devices and Internet plans can be prohibitive for low-income families. Variations in proficiency levels with technology among learners and teachers further exacerbate the issue, as some may struggle with software, navigating online platforms or critically evaluating information sources. Addressing digital inequality in higher education requires a reliable strategy, especially in rural areas of developing nations. Comprehensive and culturally sensitive digital content can help bridge these gaps and create a more inclusive educational environment. This chapter explores digital inequality and the role of service providers in mitigating these challenges, emphasising the need to understand the current situation and take actionable steps to address digital disparities in the higher education sector.

■ Introduction

This chapter expands on the digital inequalities within the education sector and further provides insights into how to close the gap. Solutions proposed are recommended for the African region, though mainly based on the lessons learnt in South Africa. In the globalised knowledge economy, digital literacy and access to technology are crucial for academic success in higher education. However, institutions across the African continent face significant challenges in ensuring equitable access to digital resources. Higher education is vital for developing high-quality human capital and adapting to evolving technologies, which are essential in the digital age. Digital technology can greatly benefit 'rural areas by providing access to information, education, and communication resources. For instance, Internet access can connect rural students to online educational resources, job opportunities, and social networks' (Mwapwele et al. 2019). Nevertheless, implementing digital technology in rural areas is challenging because of factors such as inadequate infrastructure, lack of electricity and limited Internet connectivity (Omar et al. 2023).

According to Sadeghi et al. (2021), not all students have access to technology, leading to disparities in educational opportunities. Continuous access to technology can also cause distractions, affecting academic concentration. Matlala and Kheswa (2021) highlight that high-quality electricity is a prerequisite for information and communication technologies (ICTs) introduction in rural schools, which is often lacking and complicates ICT implementation. Oki, Uleanya and Mbanga (2023) suggest that providing free ICT education and digital devices to every secondary school student annually would ensure equal technological access, boosting academic performance and developing future ICT skills.

In South Africa, suitable infrastructure is required for students to access technology, particularly in rural schools. Chisango and Lesame (2017) point out that inadequate facilities, poorly established infrastructures and insufficient funding from the Department of Education hinder access to technology for disadvantaged students. While research has been conducted on ICT in education, specific gaps in digital inequality within the higher education sector in Africa remain unclear. Sustainable solutions to bridge these digital inequalities in higher education are still needed. Hence, this chapter provides detailed insights into the challenges of digital inequalities in the higher education sector of the African continent and charts the way forward in addressing the identified challenges.

The remainder of this chapter is organised as follows: Firstly, it presents a systematic analysis of the literature on digital inequality in the higher education sector. Secondly, it outlines and discusses the digital inequality gaps in higher education across the African continent. Thirdly, it details the emerging technologies and future trends for addressing these inequalities. Finally, the chapter concludes by including an outline of the findings and recommendations.

■ Digital inequality in the higher education sector: Systematic review

This section consists of a content analysis using bibliometric meta-analysis. The analysis was conducted in order to contribute to the knowledge in the field of digital inequalities in the higher education sector. The review uses primary and subsidiary keywords related to digital inequality in higher education to query the Scopus database. After screening for relevance and excluding duplicate documents, 218 research papers from 2014 to 2023 were analysed using R-Bibliometrix tools, a bibliometric analysis software package in R (Donthu et al. 2021). Bibliometric software has made it possible to assess scientific areas of interest by evaluating fields, subjects and topics. The study first analysed foundational data acquisition and then examined contextual areas that emerging and established researchers in the field of digital inequality in higher education are exploring, with a particular focus on further exploration opportunities in the African continent.

Based on the analysis conducted using Bibliometrix software, it can be observed from Table 5.1 that the average citation per document is higher than 14, and the annual growth is 35.11%. This implies that digital inequality in higher education remains a very active and fast-growing research area.

The result also shows the essence of collaboration among researchers, which would help to address the challenges from different perspectives.

TABLE 5.1: Main information about data collected as extracted from Bibliometrix software (2023).

Description	Results
Main information about data	
Timespan	2014–2023
Sources (journals, books, etc.)	173
Documents	218
Annual growth rate %	35.11
Document average age	3.18
Average citations per document	14.11
References	1
Document contents	
Keywords Plus (ID)	820
Author's keywords (DE)	695
Authors	
Authors	667
Authors of single-authored documents	40
Authors collaboration	
Single-authored documents	40
Co-authors per document	3.16
International co-authorships %	21.1
Document types	
Article	136
Article review	1
Book	5
Book chapter	25
Book chapter conference paper	1
Conference paper	38
Conference review	1
Editorial	3
Review	8

Source: Authors' own calculations using Bliometrix software (2023).

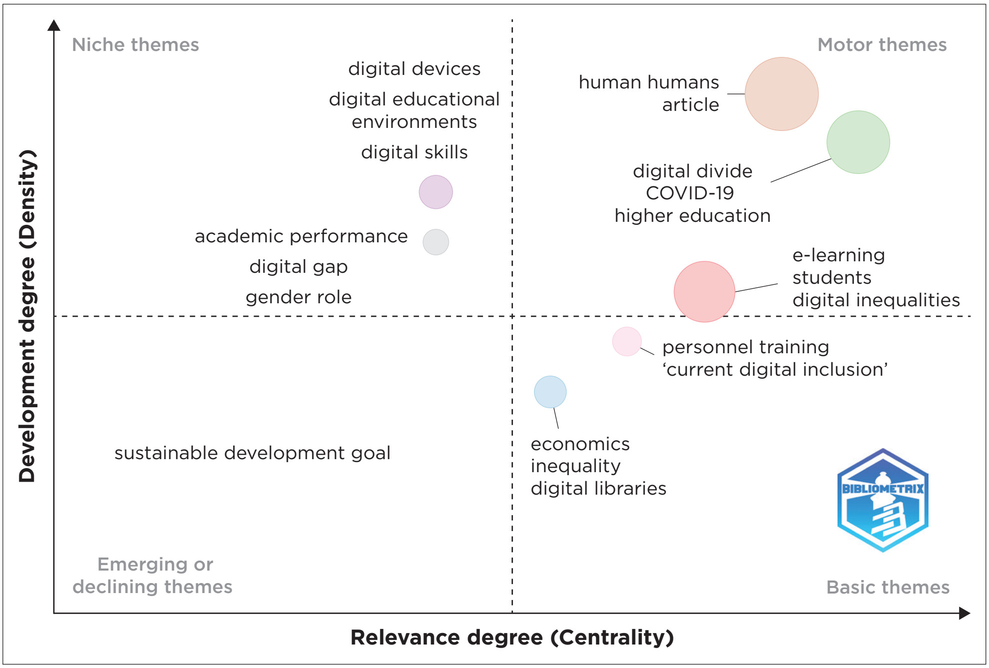
TABLE 5.2: Digital inequality in the higher education sector documents counts by countries extracted from Bliometrix software (2023).

Country	Articles	SCP	MCP	Freq	MCP ratio
United Kingdom	19	13	6	0.08715596	0.31578947
USA	16	13	3	0.0733945	0.1875
South Africa	14	12	2	0.06422018	0.14285714
Germany	12	9	3	0.05504587	0.25
Netherlands	6	4	2	0.02752294	0.33333333
Spain	6	6	0	0.02752294	0
Switzerland	5	3	2	0.02293578	0.4
China	4	4	0	0.01834862	0
Canada	1	1	0	0.00458716	0
Cyprus	1	1	0	0.00458716	0
Denmark	1	0	1	0.00458716	1
Ecuador	1	1	0	0.00458716	0
Egypt	1	1	0	0.00458716	0
Greece	1	1	0	0.00458716	0
Hong Kong	1	1	0	0.00458716	0
Iran	1	1	0	0.00458716	0
Israel	1	1	0	0.00458716	0
Kenya	1	1	0	0.00458716	0
Tanzania	1	1	0	0.00458716	0
Zimbabwe	1	0	1	0.00458716	1

Source: Bliometrix software (2023).
Key: SCP, single country publication; MCP, multiple country publication; Freq, frequency.

Table 5.2 compares the document counts related to digital inequality in higher education for up to 15 countries or territories. South Africa is the only African country represented in this chart, with 22 documents, making it the third highest contributor after the United Kingdom (30 documents) and the United States (28 documents). Based on this result, it can be observed that Africa's participation in this field is still very low. However, in order to address this low participation, other African countries should invest in research initiatives to address digital inequality in higher education, following South Africa's lead. Also, researchers should encourage collaboration between African universities and international institutions to enhance research output.

The contextual themes related to digital inequality in higher education based on their development degree (density) and relevance degree (centrality) are presented in Figure 5.1. The figure is divided into four quadrants: Niche Themes (Top-left quadrant), Motor Themes (Top-right quadrant), Emerging or Declining Themes (Bottom-left quadrant) and Basic Themes (Bottom-right quadrant). The themes most relevant to addressing digital inequality in higher education in Africa would fall into the Motor and Basic themes quadrants, such as 'digital divide', 'coronavirus



Source: Author's own work generated using the Bliometrix software.

FIGURE 5.1: Thematic or contextual areas in digital inequality in higher education.

disease 2019 (COVID-19)', 'higher education', 'e-learning', 'students' and 'digital inequalities'. African research should focus on these high-relevance themes to address the most pressing issues in digital inequality effectively. By focusing on this recommendation, Africa can better address digital inequality in higher education, ensuring equitable access to digital resources and opportunities for all students.

Digital inequality gaps in the higher education sector of the African continent

This section presents the identified gaps in digital inequality using the categorisation review method. The categorisation method adopted in this section is based on thematic issues identified from the systematic review presented in the section 'Digital inequality in the higher education sector: Systematic review'. The gap focuses on three key broad areas: The digital inequality landscape, infrastructural challenges and pedagogical implications.

The landscape of digital inequality

This section delves into the multifaceted dimensions of digital inequality in the African higher education context, highlighting disparities in access to devices, Internet connectivity, and digital literacy skills among students and academic staff (Bates 2019).

The landscape of digital inequality in higher education across the African continent is shaped by a complex interplay of factors, encompassing disparities in access to devices, variations in digital literacy levels, and unequal opportunities for engagement with digital learning resources. The key factors for the digital inequality landscape in the African continent are presented.

Accessibility to gadgets

One of the foundational aspects of digital inequality lies in the unequal access to digital devices among students. While some students may possess gadgets such as personal laptops, tablets or smartphones, a significant portion of the student population lacks access to these devices. Some studies have revealed a connection between device access and income. They claimed that higher income levels are associated with better ICT usage. Likewise, less money translates into fewer opportunities. As a result, those in developing countries with lower incomes would have less accessibility to gadgets, adding to the first degree of digital inequality (Singh, Singh & Nermend 2022). This disparity is influenced by socio-economic factors, geographic location and household income levels, creating a divide in students' ability to engage with online learning platforms and digital content (Selwyn 2017). This section shows the statistics of South African smartphone users from 2014 to 2023. Access to technology in rural areas of South Africa can vary significantly depending on the specific area and context.

Location-based inequities

The study by Cullinan et al. (2021) highlights significant digital inequalities and location-based inequities in higher education, where students from the poorest broadband coverage areas are more likely to be socio-economically disadvantaged. The digital gap continues to be a major problem influencing educational equity, especially in broadband availability. Internet connectivity is severely restricted in rural and indigenous communities, which limits their access to education and social mobility. For example, students frequently struggle to get dependable Internet connections in rural universities; as a result, they occasionally turn to drastic methods like climbing to high heights in order to get better reception (Pressley 2022). Digital inequality is further worsened by geographic disparities, with urban and peri-urban areas often enjoying better digital infrastructure and connectivity than their rural counterparts. Universities in major urban centres may have more resources and better access to high-speed Internet, placing students in rural or remote areas at a distinct disadvantage in terms of online participation and access to digital educational resources (International Telecommunication Union [ITU] 2020).

Economic and social dynamics

The socio-economic background of students significantly shapes their experiences with digital inequality. Students from affluent families may have access to a wider array of digital resources, including high-speed Internet, the latest technology devices and supplementary educational software. Conversely, students from economically disadvantaged backgrounds face barriers that limit their ability to fully engage with digital learning, perpetuating socio-economic disparities within higher education (Van Dijk 2005). According to Lin and Yeh (2022) and Treceñe (2022), COVID-19 digitalisation has had a significant impact on students in developing nations at all educational levels in many different ways. Therefore, it is imperative to ensure that educational opportunities are distributed fairly across various groups (Bihu 2022; Iyer et al. 2022; Krishnaswami et al. 2022). The higher education system is significantly impacted by the socio-economic setting. The structure, accessibility and experience of higher education are influenced by several elements, such as social institutions, cultural standards and economic status. According to Czerniewicz (2022), ICT and inequality in higher education cannot be examined in isolation; rather, tackling inequality needs to be considered in the context of larger societal realities. However, social structures in universities are where digital behaviours and structures are unevenly distributed and experienced. Universities replicate these structures and activities in a virtual cycle and modify and redefine social practices through knowledge generation and dissemination.

Cost-accessibility of data and devices

The affordability of data plans and digital devices is a critical aspect of socio-economic dimensions in digital inequality. High data costs can limit students' ability to engage in online learning activities, access educational materials and participate in virtual classrooms. Additionally, the cost of acquiring and maintaining digital devices poses a barrier for economically disadvantaged students, hindering their ability to fully participate in the digital educational landscape (World Bank 2020).

Urban-rural disparities

Studies reveal that the quality of broadband rather than its availability substantially influences academic achievements. Effective online learning requires fast and reliable broadband connections, particularly in rural areas where connectivity is frequently worse than in cities. There are obstacles that students in places with poorer broadband quality must overcome, which may decline their engagement and performance in class (Cullinan et al. 2021). Socio-economic dimensions are closely linked to urban-rural divides, with urban areas generally having higher income levels and better access to digital resources. In rural areas, where economic opportunities are often limited, households may face challenges in affording digital devices and Internet connectivity. This rural-urban disparity contributes significantly to the socio-economic dimensions of digital inequality in higher education (GSMA 2022).

☐ Technological proficiency

It is impossible to overstate the significance of technological proficiency in higher education. It includes various abilities required for future employment prospects and academic success. These abilities include the capacity to use standard software and platforms, carry out independent research and adjust to emerging technology. Higher digital literacy makes students more capable of using online resources, submitting homework via digital portals and engaging in virtual classrooms (IEEE 2024). Digital inequality is not solely about access to hardware but extends to digital literacy skills. Students with varying levels of exposure to technology enter higher education institutions (HEIs), creating a diverse landscape of digital literacy competencies. This diversity poses challenges for educators in designing curricula that cater to a range of digital literacy levels, impacting the effectiveness of digital teaching and learning strategies (Hargittai & Jennrich 2016).

☐ Language and content relevance

Using technology as a teaching and learning tool is a massive way to encourage pupils to embrace English, especially in remote areas. High education gaps are frequently linked to schools in rural areas (Mohamad, Fadzil & Yunus 2021). They face difficulties with several fundamental facilities compared to urban schools. Language barriers and content relevance also contribute to the landscape of digital inequality. Digital educational content is often presented in languages that may not be the first language for many students, impacting their comprehension and engagement. Additionally, the relevance of digital content to students' cultural context can influence their level of interest and motivation to engage with online learning materials (Warschauer & Matuchniak 2010).

☐ Gender disparities

Gender plays a role in shaping digital inequality within higher education. Studies have shown that women may face specific challenges, including societal expectations, biases and stereotypes, affecting their access to and engagement with digital technologies. Addressing gender disparities in digital access and literacy is crucial for promoting inclusivity within higher education (Gurumurthy et al. 2019). There are still notable differences in many areas, even though the first-level digital gender divide in access to technology has begun to narrow. Particularly in developing nations, males are more likely than females to have access to computers and the Internet. Males and females often hold different views about technology, with males generally exhibiting more positive attitudes and stronger self-efficacy in utilising digital tools (Campos & Schere 2024).

☐ Intersectionality of inequalities

The study by Fernandez et al. (2024) revealed that some students discussed the difficulties they face as women from low-income backgrounds and gender discrimination, particularly those from underrepresented backgrounds. These students also mentioned the need for information on how to proceed and seek support when they encounter discrimination, with gender being mentioned as one of the most important aspects of these experiences. Understanding the intersectionality of various forms of inequality is essential. Students may experience multiple layers of disadvantage, including gender, socio-economic status and geographic location. One possible explanation for the persistence of inequality is that the higher education strategy failed to define disadvantage precisely in a number of its actions. While enrolment statistics demonstrate parity levels appear to have reached gender equality, some female students continue to face disadvantages because of subtle forms of discrimination and sexual harassment in higher education (Gore 2021). Intersectionality shares a different model that offers an opportunity to look at structural inequalities and endorse social justice action to generate political and transformative praxis (Fernandez et al. 2024). The compounded effects of these inequalities create unique challenges that must be acknowledged and addressed to ensure a more equitable digital landscape in higher education (Parry 2023).

By delving into these dimensions of digital inequality, HEIs, policymakers and educators can develop targeted strategies to bridge the gaps and create a more inclusive learning environment for all students.

☐ Infrastructural challenges

This section provides an in-depth analysis of the existing technological infrastructure in the African continent's HEIs, emphasising the gaps in connectivity, access to hardware and the digital divide between urban and rural campuses, as mentioned in the United Nations Educational, Scientific and Cultural Organization (UNESCO) report (UNESCO 2020). A significant portion of African students find it difficult to work remotely because they lack access to a consistent power supply and a dependable Internet connection, exposing the lack of digital infrastructure in African higher education (Czerniewicz 2022). Thereby,

> Internet access [is] one of the main infrastructure challenges in Africa, [as this has led to] the lack of reliable and affordable internet connectivity. According to the International Telecommunication Union (ITU), only 39.7% of the population in Africa uses the internet. This is significantly lower than the global average of 66.3%. A lack of internet access prevents students and teachers from using online educational resources, communicating with their peers and [participating] in digital learning activities (ITU 2022a; Vodacom 2023).

In terms of Internet access, Africa trails behind the rest of the globe despite its huge population growth compared to other continents. While coverage for mobile cellular networks is expanding, there are still issues with fixed broadband Internet connection. Although the African urban area statistics are favourable compared to worldwide norms, the reality in rural regions is very different. For instance, while 87.7% of people worldwide have access to at least long term evolution (LTE) or Worldwide interoperability for microwave access (WiMAX)-level mobile networks, just 24.6% of people in rural Africa have Internet connectivity. The infrastructural challenges associated with digital inequality in higher education across Africa are complex, ranging from insufficient connectivity to outdated hardware. The following section unpacks some of the key infrastructural challenges associated with digital inequality in the higher education sector of the African continent.

Limited technology and Internet access

A predominant challenge in many African HEIs is the limited availability of reliable Internet connectivity. Insufficient bandwidth and slow Internet speeds hinder the seamless integration of online learning platforms, video conferencing tools and other digital resources into the educational process. This limitation disproportionately affects students and faculty in remote or rural areas, exacerbating the urban-rural digital divide (ITU 2019). The lack of personal devices is another challenge in many African HEIs, where many students do not have personal computers or devices necessary for online learning. This hinders their ability to participate in digital classrooms and complete assignments.

The challenge of last-mile connectivity is a critical one that must be addressed. The term ‘last-mile connectivity’ typically refers to the final stage of a service provider’s providing Internet access to the end-user. This remains a persistent challenge in many regions of the African continent. Remote campuses and educational institutions in geographically isolated areas may face difficulties in establishing the necessary last-mile connections, limiting access to the digital resources available on the broader Internet (GSMA 2020).

Unequal access to digital devices and educational resources

The utilisation of digital devices can facilitate the growth of social networks and enhance social interaction skills in adolescents, ultimately benefiting their academic progress (Wang et al. 2024). Additionally, the availability and affordability of digital devices such as laptops and tablets are critical factors in determining students' access to online learning resources. However, a significant portion of the student population in Africa may lack personal access to these devices. Institutions often face challenges in providing adequate devices for student use, further contributing to the digital divide (Aluede 2017). Also, the limited access to extensive digital libraries is affecting the quality of research and academic work for many students. The disparities between developed and developing nations in the realm of educational digital inequality are apparent from the outset (Wang et al. 2024). However, targeted initiatives can provide computers, tablets or smartphones at reduced prices or with financial assistance. Collaborations among technology companies, educational institutions and government agencies can secure funding and resources for these initiatives (Afzal et al. 2023). Prioritising infrastructure development to enhance Internet access in rural and underprivileged areas is also essential.

Digital proficiency and skills imbalance

Digital competence and skills disparity significantly contribute to digital inequality, influenced by multiple elements. Disparities in technological literacy, frequently shaped by socio-economic factors, hinder individuals' capacity to interact proficiently with digital tools and platforms. The following section provides a comprehensive overview of the key contributors to digital proficiency and skills imbalance, which play a significant role in perpetuating digital inequality:

- *Unequal technology literacy*: Students from varying socio-economic backgrounds may have different levels of familiarity and comfort with digital technologies. This disparity can affect their ability to navigate online learning platforms and use digital tools effectively.
- *Skills imbalance*: Ensuring that all individuals are knowledgeable about recent technological advancements and possess the necessary training and experience to utilise technology advancements effectively is crucial (Afzal et al. 2023).
- *Limited technology training*: Some institutions may not have the resources to provide comprehensive training on digital tools and platforms, leaving students disadvantaged in a digitally driven academic environment.
- *Digital proficiency promotion*: Integrating digital literacy into curricula and offering training workshops can provide students with skills to

navigate digital platforms, critically evaluate content and collaborate online (Afzal et al. 2023). Particularly, online technologies are essential for ensuring equal access to the information economy, thus aiding governments in delivering electronic services and empowering individuals to capitalise on the economic growth potential of the information age.

Cybersecurity and funding challenge

Cybersecurity encompasses safeguarding Internet-connected systems, including information, software and hardware, against malicious assaults. With the growing integration of digital technology into our everyday lives, the significance of cybersecurity is on the rise.

South Africa is lagging behind leading countries in several aspects of cybersecurity, such as insufficient legislation, weak government coordination, inadequate participation from industry and citizens, and a shortage of skilled professionals. Additionally, it is facing threats from foreign adversaries, terrorists and criminal elements. Despite these challenges, the country is trying to improve its cybersecurity posture (Sutherland 2017).

In an increasingly digital educational landscape, cybersecurity is of paramount importance. However, many African HEIs lack robust cybersecurity measures, making them vulnerable to cyber threats and attacks. This not only jeopardises sensitive student and institutional data but also undermines trust in digital platforms (African Union 2018).

The individuals impacted by digital inequality are often the most susceptible to cyber-attacks for many reasons, such as insufficient awareness and education. People who have limited opportunities to use digital technology lack an understanding of fundamental cybersecurity measures (Khoza 2023).

Economic constraints hinder people from investing in essential cybersecurity measures, such as antivirus software, firewalls and secure cloud services because of financial restraints. Findings suggest that students belonging to households with low incomes and minority groups have limited access to digital technology, resulting in decreased academic performance and worse educational results (Miah 2023).

The absence of appropriate digital infrastructure in several developing countries presents difficulties in the implementation and maintenance of efficient cybersecurity measures. Effective management of facilities and infrastructure in educational institutions is crucial. When planning is properly controlled, it will undoubtedly align with the expectations and intended objectives of a high-quality learning process (Wajdi, Putra & Arif 2023).

Insufficient financial resources pose a significant barrier to addressing infrastructural challenges. Many institutions lack the necessary funding to invest in upgrading digital infrastructure, expanding connectivity and ensuring the availability of modern technology. This creates a cycle where underfunded institutions struggle to provide quality digital education (World Bank 2020).

By tackling the issue of unequal access to digital resources and improving methods to protect against cyber threats, we can establish a digital environment that is both inclusive and safe. By safeguarding both persons and communities, this measure promotes economic development and social unity in the era of digitalisation.

Collaboration and public–private partnerships

Effective solutions to infrastructural challenges require collaborative efforts between educational institutions, government bodies and the private sector. Public–private partnerships can play a vital role in addressing funding constraints, leveraging expertise and implementing sustainable solutions to enhance digital infrastructure in higher education (ITU 2021).

By comprehensively understanding and addressing these infrastructural challenges, stakeholders can work towards creating an environment where all students and educators have equitable access to the digital resources necessary for a quality higher education experience.

Collaboration and partnerships between the public and commercial sectors are essential for tackling the issue of digital inequality in higher education. By using the capabilities and assets of many stakeholders, these collaborations can provide a digital environment that is fair and accessible to all students.

Infrastructure of educational institutions

The digital infrastructure of HEIs plays a crucial role in supporting modern pedagogical approaches. However, many African institutions grapple with outdated or inadequate digital infrastructure, including insufficient computer labs, outdated servers and a lack of cybersecurity measures. This hampers the effective implementation of digital learning initiatives and puts sensitive educational data at risk (UNESCO 2020).

Power supply challenge

Reliable access to electricity is a prerequisite for a robust digital infrastructure. However, many African regions, particularly rural areas, face frequent power outages and unstable electricity supply. This directly impacts the functionality of digital devices, disrupts online learning sessions and poses challenges for the sustained use of technology in education (World Bank 2018).

A suitable strategy is needed to address these infrastructural difficulties, including investments in technology infrastructure, student financial aid, faculty training programmes and equal access to digital resources. Institutional and policy-level initiatives are crucial to closing these digital gaps in the African higher education sector.

Pedagogical implications

The influence of ICT on teaching has been significant and far-reaching in several respects that cannot be disregarded. The extensive use of ICT technologies in education plays a pivotal role in enhancing the teaching and learning process in the education sector, as highlighted by Ramafi (2022). Despite the South African government's efforts to incorporate ICT tools in teaching and learning by designing the curriculum to promote their use and providing some ICT tools in public schools, challenges persist in fully integrating these tools (Ramafi 2022). It is acknowledged that ICT has the potential to significantly impact economies and communities by reducing information and transaction costs, creating new collaboration models to increase worker efficiency, encouraging innovation, facilitating access to essential services and enhancing education. Extensive studies have been conducted in recent years on using ICT in the classroom. Furthermore, it has substantially impacted the area of pedagogy in several ways. Hence, the growing use of ICT technologies in education cannot be ignored.

Pedagogy, as a scientific discipline, encompasses several key categories, including upbringing, education and training. It is important to note that these processes are naturally interrelated, and together they form the pedagogical system, which encompasses the larger system of public education, including schools and classes, where purposeful education is carried out (Belessova et al. 2023).

The deficiency of data infrastructure, particularly in rural areas, is a major contributor to digital inequalities. This is because of the unavailability and high expenses associated with data infrastructure in these regions, which results in a lack of access to this essential service (Mugizi & Amwine 2020). This disparity in service provision between urban and rural areas exacerbates the existing inequalities and hinders the growth of digital opportunities (Pillay 2021).

The Learn-O-Vision initiative, spearheaded by D. Oosthuizen, seeks to equip rural schools with advanced teaching aids. The project features a solar-powered computer, television, video machine, and writing and flannel board, all in a compact and secure unit that is easily installable in any rural school (Herselman 2003). Widespread implementation of the Learn-O-Vision unit across provinces could provide remote schools with Internet access and improve educational quality for rural students (Herselman 2003).

Ngololo, Howie and Plomp (2012) state that Namibia's national policy aims to equip learners, students, instructors and communities with essential skills and knowledge for the global economy. It emphasises fostering ICT proficiency and effective use of technology for information access. The policy also seeks to develop individuals capable of contributing to ICT-driven economies and societies. Additionally, it aims to enhance learning for students and teachers across subjects through ICT and expand access to high-quality education at all levels (Ngololo et al. 2012). South Africa ought to offer continuous, long-term support to such schools in order to upgrade and maintain their equipment, considering the rapid and continuous advancements in digital technology (Mzangwa & Dede 2019). Additionally, the state should initiate skill development programmes for teachers in these schools to equip them with the necessary skills to utilise modern technology more effectively (Nukunah, Bezuidenhout & Furtak 2019). Moreover, the state should contemplate offering training programmes to parents and adults to enhance their digital literacy and foster a greater understanding of technological progress (Munje & Jita 2020). Ultimately, the government must provide resources towards the essential infrastructure in the ICT industry to facilitate digital transformation and improve rural connectivity in rural areas (Dimitriadou & Lanitis 2023; Pillay 2021).

☐ Differential access to educational resources

Digital inequality poses a significant challenge to students' access to educational resources, directly impacting the quality and quantity of materials available for learning. Educators face the daunting task of designing courses catering to differing access levels to textbooks, online journals and multimedia resources. Consequently, this unequal access can create an imbalanced learning environment where certain students are better prepared to engage with the curriculum than others, thereby exacerbating existing educational disparities (Belessova et al. 2023). Students in affluent nations have widespread access to the Internet, and most of them have personal connections that provide a high level of independence. However, simply having access to infrastructure is insufficient to ensure equal opportunities for all students, as disparities in skills, intensity and purpose exist. The existence and purpose of academic achievement are impacted by several elements, which may have a substantial effect (Chisango et al. 2020). Evaluation of technology integration ought to be conducted concurrently with the challenges of teaching and learning. These challenges encompass establishing learning objectives, selecting appropriate instructional techniques, providing feedback, as well as devising evaluation and assessment methodologies, accompanied by follow-up activities. It is crucial to consider technology employed in teaching and learning as an indispensable component of instruction rather than as a distinct entity (Okojie, Olinzock & Okojie-Boulder 2006).

Varied technological proficiency

Undoubtedly, students embark upon their higher education journey with diverse levels of technological proficiency, shaped by various factors such as socio-economic background, geographic location and prior educational experiences. Socio-economic status plays a significant role in determining 'computer anxiety' among students. Specifically, students from lower socio-economic backgrounds are more likely to experience negative emotions when using a computer, which contributes to their reduced usage of the Internet (Oyedemi 2012). Educators are confronted with the formidable task of bridging this proficiency gap, enabling students with limited digital exposure to effectively navigate online learning platforms, collaborate on digital projects and harness technology for academic success. This demanding challenge requires a more adaptable and inclusive approach to curriculum design and delivery (Chisango et al. 2020).

According to Maceviciute and Wilson (2018), several prerequisites must be fulfilled for this enhancement to take place. First and foremost, the learner must have a genuine interest in acquiring knowledge. The relationship between educational achievement and Internet use for studying and exam preparation is not straightforward, because students who depend on the Internet for these reasons are likely to have worse results than those who do not. The second requirement is that HEIs incorporate the use of the Internet into their teaching methodology (Maceviciute & Wilson 2018). Incorporating digital literacy into school curriculum and suggesting instructional programmes are crucial for giving students the essential abilities to proficiently traverse technology and use it for academic purposes. It is crucial to educate students on topics such as online safety, information literacy, digital collaboration and critical thinking (Afzal et al. 2023).

Diverse learning styles

The issue of digital inequality has a profound impact on the diverse learning styles present within a classroom. As a result, educators are compelled to employ adaptable teaching techniques that can accommodate a range of preferences and needs. While certain students may excel in digital learning environments, others may find online formats challenging (Larghi et al. 2015). To address this heterogeneity, it is essential to integrate various instructional methods, blending conventional teaching techniques with digital resources, to ensure that all students can benefit from their learning experience. The utilisation of adaptive learning technologies and personalised strategies is paramount in addressing these disparities (Mphahlele, Mokwena & Ilorah 2021).

The implementation of evidence-based approaches by educators to bridge the achievement gap and promote academic success for all students can be facilitated by addressing the digital divide. In the contemporary digital era, digital literacy is a vital skill that is crucial for students' future success (Afzal et al. 2023). By investigating technology's access and utilisation in education, researchers can pinpoint inadequacies in digital literacy skills and formulate strategies to improve them.

Cultivating digital literacy

Addressing the issue of digital inequality demands a renewed emphasis on cultivating digital literacy skills among students. Educators hold a pivotal position in disseminating subject-specific knowledge and nurturing the growth of crucial digital literacy skills (Munje & Jita 2020). This encompasses the capacity to assess online information, navigate digital platforms responsibly, and harness technology for productive communication and collaboration. Emphasising the importance of acquired technological skills to address the issue of the second-level digital divide is crucial. This phenomenon refers to the significant skill disparity that will determine individuals' ability to participate in society (Olaitan & Mavuso 2022).

In order to create inclusive and equitable learning environments, educators and policymakers must comprehensively understand and address the pedagogical implications and tackle the instructional ramifications of digital technology (Goksel 2022). By doing so, they can develop effective strategies that ensure all students have the opportunity to thrive in the ever-evolving digital landscape of higher education.

To foster innovation and creativity and contribute to the knowledge economy, HEIs must invest in implementing curricula and instructional methods that result in the achievement of educational objectives such as analytical thinking, solution-oriented thinking, effective communication, teamwork, the ability to find and evaluate information and skills for global engagement (Goksel 2022). It is essential that these institutions have explicit and deliberate strategies for developing digital literacy, leveraging the competencies that students, teachers and staff possess while also enhancing their ability to select relevant and pertinent information, adhering to scientific criteria in each field and improving their digital proficiency (Santos & Serpa 2017).

Technological integration into pedagogy

The issue of digital inequality necessitates that educators reflect critically on their methods for incorporating technology into their teaching. Although technology-enhanced learning can provide significant benefits, educators must carefully navigate the potential for exacerbating the inequality that comes with utilising digital tools (Chisango et al. 2020). In light of this, professional development programmes become imperative for equipping educators with the necessary skills and knowledge to integrate technology in a manner that is both effective and equitable (Kuhn et al. 2023).

The students, in addition to their Internet connections, generally have institutional-level Internet access. Universities in wealthy nations have provided the essential infrastructure to their university community, including enough technology resources for the small percentage of students who lack computer and Internet access (Castaño-Muñoz 2010).

The primary focus on literacy is the acquisition of digital skills and their conversion into digital proficiencies. The discourse around digital skills often leads to a collision of beliefs, specifically a confrontation between different generations: should pupils be instructed in these abilities, or will those considered digital natives ultimately instruct their non-digital teachers? (Yu et al. 2016). It is likely a bit of both, as neither group fully masters the digital arena with the emergence of new educational patterns and theories. To facilitate technology integration, it is recommended that a professional development programme be implemented to best equip educators (Hero 2019). In the context of higher education, the e-readiness Model has introduced new patterns, techniques and ideas to adapt education to the digital world and deliver innovative content and services (Peña-López 2010).

The issue of promoting and developing digital literacy competencies in students is not straightforward. Higher education institutions, as well as their educators, may not be adequately prepared to do so. At most universities, digital literacy is either assumed to be acceptable or taken for granted, rather than assessed, remediated and enhanced. It is imperative that the academy address this shortcoming by incorporating digital literacy as a fundamental aspect of its core curriculum.

Case studies of digital inequality in the African education sector

Ghana

Ghana's goal of developing into a high-income economy and society rich in information, knowledge and technology is shown in adopting the Information and Communication Technology for Accelerated Development (ICT4AD) policy in 2003 (Arthur-Nyarko & Kariuki 2019). This approach aims to promote and encourage remote education, including electronic distance education and computer-based learning, mainly at the university level. The objective is to increase the accessibility of educational and training resources and services to a broader segment of the population (Arthur-Nyarko & Kariuki 2019).

Ghana has been steadfast in pursuing to become a preeminent information technology leader in West Africa for over a decade. Currently, Ghana boasts 16 tech hubs, one of the region's highest numbers. This approach has not only strengthened and expanded the local ICT workforce, but it has also provided skilled talent for ICT initiatives in various sectors, including education (Pete et al. 2018).

The Internet is essential for increasing the availability of high-quality education to learners. The advent of the Internet has revolutionised the educational landscape, turning it into a collaborative learning community where information is shared and discussed. Hence, having access to the Internet is crucial for keeping uninterrupted involvement with the wider population of learners (Gyaase et al. 2019). Access to ICTs and electricity substantially impacted learners' preferences for e-learning delivery modes. However, the study found that Internet access did not significantly influence these preferences. Therefore, the research suggested that the government implement a programme to provide cost-effective ICT gadgets to students engaged in remote education. Furthermore, it is imperative that Internet service providers in Ghana provide dependable, cost-effective and easily available Internet services to these students (Arthur-Nyarko & Kariuki 2019).

One of the factors that has hindered the development of e-learning in Africa is the lack of reliable access to electricity. A significant number of e-learning installations in Africa and other developing countries are plagued by an inadequate and unreliable source of electricity. This issue has the potential to affect students' preference for e-learning as a delivery mode. Factors such as fluctuating and unreliable electricity supply, lack of financial resources, high costs associated with e-learning content development, computer ownership and availability, Internet access and computer competency are significant resources that influence the uptake of e-learning.

In addressing the difficulties associated with training educators in ICT technologies, several measures should be implemented. Firstly, it is essential to ensure the provision of ICT resources, including computer labs and equipment, to schools. Secondly, guaranteeing a stable supply of electricity is crucial for the smooth functioning of these resources. Thirdly, enhancing school security measures is necessary to provide a safe learning environment for students and educators. Fourthly, improving Wi-Fi connectivity in schools will enable educators to access online resources and enhance their teaching skills. Fifthly, government support, including financial and technical assistance, is vital to ensure the successful implementation of ICT integration in schools. Sixthly, the development of effective ICT policies that align with the educational goals of the country is necessary. Seventhly, it is essential for educators to have training in ICT technologies in order to proficiently incorporate them into their teaching methodologies. Ultimately, it is crucial to provide continuous assistance and materials to teachers, such as possibilities for professional growth, in order to maintain the incorporation of ICT in educational institutions.

The ICT policy must address the security issue, as South Africa has high crime rates in schools, as evidenced by the cases of Western Cape and Gauteng provinces when they were the first to implement ICT integration in schools. Theft is a significant contributor to the dilapidated state of laboratories, and therefore, security measures must be put in place to ensure the safety of schools. Full-time security and alarm system controls would be ideal to benefit the holistic safety of the school. Additionally, security measures such as burglar doors, windows and cameras would be helpful if thieves already have access to the school's premises. Furthermore, it is essential to empower all schools to ensure that they are adequately equipped to implement effective security measures (Naz et al. 2022).

Tanzania

Iringa University College (IUCo), a subsidiary of Tumaini University and organised under the Evangelical Lutheran Church of Tanzania, is a HEI that faces various challenges in Tanzania's power distribution network. This poses a significant obstacle to e-learning prospects nationwide. The inconsistent and erratic electrical supply negatively impacts the durability and reliability of ICT equipment. Although uninterruptible power supplies (UPS), surge protectors and voltage stabilisers can safeguard equipment from power issues, the primary challenge lies in the substantial costs and specialised expertise needed to maintain the entire system. This encompasses the management of computer software and hardware, power protection devices, electrical grid and wiring, grounding, shielding and the immediate environment (Lee, Yuan & Wang 2022).

Economic limitations frequently oblige system administrators to opt for cost-effective alternatives, which may prove more expensive because of the frequent breakdown of cheap equipment, resulting in lost workdays and increased demand for spare parts. Computer prices in developing nations have been set at high levels by the main manufacturers, and foreign exchange rates for the Tanzanian currency are seldom favourable.

The decisions made by the government of Tanzania have demonstrated their significance in various aspects of e-learning. One such instance is the implementation of no import tax or duty charged on computer equipment specifically designed for educational purposes. Despite this tax exemption, computers remain more costly in Tanzania than in countries such as Europe and the United States of America.

In numerous developing countries, most students in HEIs typically lack any knowledge or skills related to ICT. Although a few schools in Tanzania have been given a restricted amount of donated computers that are potentially functional and modern, it is clear that most pupils lack computer literacy when they start university. Consequently, students' ICT skills are primarily derived from their experience with mobile phones.

E-learning presents several potential benefits; however, the widening digital divide impedes the ability of developing countries to realise these advantages. Activities that are bandwidth-intensive, such as podcasts, video material, video lectures, video conferencing and synchronous collaborative learning over the Internet, are becoming increasingly prevalent but remain inaccessible to students in developing countries. Additionally, many aspects of Web 2.0 are also unavailable to these students (Imran 2023).

Nigeria

The research conducted by Onyemechi Okocha and Edafewotu (2022) reveals that the digital gap in Nigeria is mainly caused by socio-economic hardship and inequalities in infrastructure between rural and urban areas. Moreover, the research indicates that this divide is a deliberate institutional and political phenomenon. The potential consequences of the digital divide necessitate a comprehensive approach that promotes inclusive economic growth (Abdulkareem & Lennon 2023). It is suggested that closing the digital divide in Nigeria is crucial for fostering equitable and sustainable socio-economic development. The substandard service in Nigeria may be ascribed to constraints in communication network capacity, inadequate infrastructure to sustain technological hardware and software, a scarcity of financial resources and an unreliable power supply (Abdulkareem & Lennon 2023).

The various challenges that exist in Nigeria make it difficult to use ICTs, especially in rural areas. The obstacles include disparities in Internet and world wide web accessibility, insufficient knowledge of search engines, subpar Internet connection reliability, low competence in the English language and a diverse array of socio-economic issues (Okoye, Uchenna & Eme 2023). The government is responsible for distributing Internet infrastructure, but there is a significant gap between communities and geopolitical zones. To address this issue, the government must improve telecommunication and electrical infrastructure in rural areas and make data and telecommunication devices more affordable (Onyemechi Okocha & Edafewotu 2022).

South Africa

For several decades, rural South African schools have grappled with challenges from their marginalised context, including the dearth of classrooms and inadequate access to essential services such as water, electricity and landline telephones (Hlalele 2012). More recently, digital technology has brought forth new hurdles for schools in rural areas of South Africa. In order to enable these schools to overcome these obstacles, existing rural-urban digital disparities must be addressed (Du Plessis & Mestry 2019). Because education level can influence digital inequalities, incorporating ICT equipment and imparting digital literacy training in rural schools is a crucial subject (Pillay 2021).

The issue of digital inequalities parallels social inequalities, whereby access to technology, including the Internet, is limited or restricted among certain population groups (Ramafi 2022). Mwim and Kritzinger (2016) claim that this issue impacts people from varied socio-economic origins. Digital disparities comprise pricey handsets, exorbitant data costs and poor connection capacity. In South Africa, rural poverty and education are among the main challenges that need to be addressed (Goksel 2022). Rural schools have several hurdles, such as restricted financing from the government, a lack of resources, underqualified instructors and multigrade teaching, which hamper educational achievement (Imran 2023). These barriers can be attributed to internal and external factors 'within school structures and the external environment, including local communities and education authorities' (Naz et al. 2022).

South Africa has enacted policies to enhance the use of ICTs in education, such as the South Africa Connect national broadband strategy of 2013. This strategy aims to provide broadband connections to all primary and secondary schools by 2030, ensuring comprehensive broadband Internet access. It emphasises expanding teachers' Internet access to utilise learning resources that can improve classroom teaching and develop students' digital skills (Herselman 2003). To address rural school challenges, initiatives such as the School Net project in Mpumalanga province and a proposed online portal for rural schools have been suggested. However, these efforts are impeded by the lack of electricity in some rural communities (Herselman 2003).

Namibia

In 1993, the Ministry of Education in Namibia published a document called 'Towards Education for All', as stated by Matengu (2011). This brief outlined three important objectives for educational progress in the country: ensuring access, promoting equity and fostering equality. The government had a hurdle in achieving these goals because it required providing all schools with the same resources, such as competent instructors and well-equipped laboratories (Ngololo et al. 2012). According to Matengu (2011), the National ICT Policy Implementation Plan was initiated in rural schools where teaching had proven difficult. The initiative aimed to address the low usage of ICT and pedagogical practices in rural schools, which were thought to be impeded by the lack of training programmes for professionals, instructional assistance and ICT-related resources (Afzal et al. 2023).

Emerging technologies and future trends

The dynamic landscape of emerging technologies presents opportunities and challenges for addressing digital inequality in higher education across Africa. As highlighted in the section ‘Digital inequality gaps in the higher education sector of the African continent’, to bridge the identified gaps, there is an urgent need for the adoption of emerging technologies, especially in the African continent. This section examines the impact of integrating cutting-edge technology, such as platforms for online education, augmented and virtual reality (VR), and artificial intelligence (AI), on creating educational settings that are more inclusive and accessible.

Online learning platforms and massive open online courses

The proliferation of online learning platforms and massive open online courses (MOOCs) has reshaped the accessibility of education. This section investigates how African HEIs are leveraging MOOCs and online platforms to expand access to quality educational resources. The case studies presented in the section ‘Case studies of digital inequality in the African education sector’ highlight initiatives that promote collaboration between universities, industry partners and international organisations to develop and deliver online courses, fostering a more inclusive learning environment (Panda & Mishra 2007).

Given the widespread use of mobile devices across the continent, online learning platforms and MOOCs are gaining traction as they provide accessible and flexible learning opportunities. Students can get educational resources and engage in tasks at their own speed and convenience, thereby circumventing limitations related to location and time (Al-Rahmi et al. 2018). One of the primary benefits is the global reach of online learning platforms. Massive open online courses attract learners worldwide, fostering an inclusive learning community where individuals from diverse backgrounds can share perspectives and experiences (Al-Rahmi, Othman & Musa 2014).

Online learning platforms focus on skill development, offering courses designed to enhance specific competencies. Learners can earn certifications upon course completion, providing tangible evidence of acquired skills to employers and institutions (Othman et al. 2018). Online learning often eliminates physical infrastructure, reducing costs associated with traditional classrooms and printed materials. This cost-effectiveness makes education more affordable and accessible to a broader audience (Al-Rahmi et al. 2019).

Although online learning platforms and MOOCs are emerging technologies with several benefits, data affordability, limited connectivity, digital literacy skills and high dropout rates are some very important challenges that need to be addressed in the continent of Africa (Al-Rahmi et al. 2018). Digital literacy skills are needed by the learners to navigate digital platforms, access online resources and effectively engage with multimedia content, posing challenges for those with limited or no digital literacy. This is the case with most learners from the rural and semi-urban areas of the African continent (Othman et al. 2018). Moreover, the lack of in-person communication is a notable disadvantage of online education, resulting in some students discontinuing their studies. Factors such as lack of motivation, time constraints or insufficient support mechanisms also contribute to these dropout rates (Makoe & Olcott 2021).

Virtual and augmented reality for immersive learning

Virtual reality and augmented reality (AR) represent cutting-edge technologies that have the potential to revolutionise the landscape of education (Al-Ansi et al. 2023; Siddiqui et al. 2022). These immersive technologies offer unique opportunities to transform traditional learning experiences, providing students with realistic, interactive and engaging environments (Yang 2023). Virtual reality and AR bring the world into the classroom by enabling virtual field trips. Students can explore historical sites, ecosystems and cultural landmarks without leaving the classroom. This immersive approach enhances the learning experience, making it more memorable and engaging (Samala et al. 2023).

In science and engineering disciplines, VR and AR simulations offer a safe and cost-effective alternative to traditional laboratory experiments. Students can conduct experiments in virtual environments, fostering hands-on learning experiences that mimic real-world scenarios. Language acquisition is enriched through immersive experiences. Virtual reality and AR language apps create virtual environments where learners can practise conversations, navigate real-life scenarios and enhance language proficiency through contextual interactions (Yang 2023). Virtual reality and AR can make education more accessible to diverse learners. For instance, individuals with different learning styles or those who struggle with traditional classroom settings may find immersive learning environments more accommodating.

However, in the context of the African continent, cost and content creation are very important issues that need to be addressed. The initial costs associated with VR and AR implementation, including hardware and software, can be a barrier for many higher educational institutions in the continent (Fragkaki et al. 2020). Hence, ensuring accessibility for all students, regardless of socio-economic background, is a crucial consideration. Also, creating high-quality and curriculum-aligned content for VR and AR can be resource-intensive. The academic staff may face challenges in developing or sourcing content that aligns with specific learning objectives.

The incorporation of VR can transform the educational experience by offering comprehensive and dynamic educational environments, particularly in regions with limited resources like the African continent (Al-Rahmi et al. 2019; Makoe & Olcott 2021).

Artificial intelligence for personalised learning

Artificial intelligence is revolutionising the educational landscape, particularly through the application of personalised learning, such as adaptive learning platforms, intelligent tutoring systems, personalised learning paths and predictive analytics for student success. The AI-powered adaptive learning platforms utilise algorithms to assess individual learner progress and adapt the content in real time. This ensures that learners receive personalised challenges and support, tailoring the educational experience to their unique needs and learning pace (Van der Vorst & Jelicic 2019). Artificial intelligence also enables the creation of personalised learning paths based on learners' strengths, weaknesses and preferences. This approach ensures that educational content aligns with individual learning styles, fostering a more engaging and effective learning experience. Artificial intelligence-driven predictive analytics help analyse vast datasets to identify patterns and trends related to student success. The academic staff can use these insights to predict potential challenges, intervene proactively and provide personalised support to at-risk students, thereby improving overall retention rates (Van Staden & Naidoo 2022).

However, despite all the AI-enabled advantages, the implementation cost and training of academic staff on how to effectively use AI remain important issues that need to be addressed in the African continent, to be able to enjoy the benefits that come with AI-driven education (Fragkaki et al. 2020).

Shaping an equitable digital future for higher education in Africa

As we peer into the future of educational technology, several key trends are set to transform the landscape of higher education in Africa. This section identifies the collaborative efforts required from policymakers, educators and technology developers to ensure an inclusive and equitable digital future.

Future trends should prioritise making educational technology accessible to all, including learners with disabilities and those in remote areas. Policymakers need to enforce accessibility standards, ensuring that technology developers create inclusive solutions. Educators will need to undergo training to support diverse learning needs (Ndofirepi et al. 2021).

Collaboration platforms can facilitate global connectivity, enabling students to engage in cross-cultural and international learning experiences. Policymakers should encourage partnerships between educational institutions at both regional and global levels. Educators can leverage these platforms to broaden the horizons of their students and promote cultural exchange (Das, Malaviya & Singh 2023).

Blockchain technology has the potential to streamline credential verification processes, reducing fraud and ensuring the authenticity of academic qualifications. Policymakers can explore the implementation of blockchain-based credentialing systems at a national level. Educators need to be involved in the design and verification processes, ensuring the accuracy and relevance of blockchain-based credentials (Ocheja et al. 2016).

Gamified learning platforms and educational entertainment (edutainment) tools can engage students in a more enjoyable and effective learning process. Policymakers might consider incentivising the development and integration of gamified educational content. Educators can incorporate gamification principles into their curriculum to enhance student motivation and participation (Arnold 2014).

This section identifies the potential of emerging technologies and emphasises the collaborative efforts required from policymakers, educators and technology developers to shape a future where digital innovations bridge gaps and create an inclusive higher education landscape across Africa. By staying proactive and adaptable, stakeholders can ensure that the benefits of technological advancements are equitably distributed, fostering a vibrant and dynamic educational ecosystem.

Conclusion

The conclusion of this advanced chapter serves as a synthesis of key findings, emphasising the urgency of addressing digital inequality in higher education across the African continent. It encapsulates the overarching themes explored throughout the chapter. It proposes actionable insights for stakeholders, policymakers and educators to consider in order to foster a more inclusive and equitable learning environment. The global digital divide, a persistent issue of great significance, continues to demand the attention of policymakers. To effectively address this challenge, it is essential to thoughtfully consider and devise a fresh and adaptable political agenda that builds upon, yet surpasses, previous initiatives to bridge the digital divide. The rallying cry of 'digital inclusion for all' has inspired many governments, particularly those in nations with high Internet penetration, to take substantial steps towards realising this goal. The policymakers should revisit the socio-economic, infrastructural and pedagogical dimensions, emphasising the interconnectedness of these factors in shaping the educational landscape. This conclusion also provides practical strategies for HEIs to enhance their role in mitigating digital inequality. It encourages institutions to prioritise digital literacy programmes, invest in innovative technologies and establish partnerships with industry and government entities to expand access to digital resources. The chapter underscores the role of educators as change agents in fostering a culture of digital inclusivity and emphasises the need for continuous adaptation and collaboration to meet the evolving needs of higher education in Africa. It encourages African nations to leverage global partnerships, share best practices and participate in collaborative research initiatives.

In essence, this chapter proposes a comprehensive and forward-looking synthesis, urging stakeholders to collectively strive towards an inclusive digital future for higher education, especially across the African continent. The next chapter presents a different sector which has experienced many inequalities. Apart from education, agriculture is also a key sector in South Africa; therefore, the next chapter discusses in depth how digital inequalities have affected service delivery in the agriculture sector within South Africa.

Chapter 6

Digital divide in the agriculture sector for small-scale rural farmers in South Africa

Agyei Fosu
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Abstract

The results revealed a lack of capacity regarding technological knowledge and infrastructure among participants to effectively use the emerging technologies associated with e-agriculture. Although 48% of the participants believed e-agriculture technologies would enhance their farming activities, the complexity factor indicated that 88% of the farmers lack access to necessary information and communication technology (ICT) tools, such as laptops and personal computers, which some of the emerging e-agriculture technologies rely on. E-skills and access to these technologies are crucial for enhancing the efficiency of rural small-scale farmers amid the e-agriculture revolution. Therefore, the study recommends developing a training programme by the municipal sector responsible for promoting rural agricultural development to provide e-skills to small-scale

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farmers in the study area. Additionally, the government sector responsible for promoting agriculture in Raymond Mhlaba Local District Municipality rural areas should assist farmers through grants for farming inputs to acquire the necessary e-agriculture technologies to boost their productivity. This chapter highlights the practical implication that policy developers and agencies supporting rural agriculture need to make actionable decisions.

Introduction

As discussed in the previous chapters, digital inequalities have been experienced in various areas, including education. This chapter focuses on digital inequality within the agricultural sector. Agriculture is one of the critical sectors of the South African economy (Gqabi 2020). This chapter explores the e-agriculture digital divide among South African rural small-scale farmers. The United Nations Economic and Social Development of Western Asia (UNESCWA 2020) explains that e-agriculture uses the Internet and innovative technologies such as information and communication technologies (ICTs) to enhance agricultural services and information delivery. This explanation of e-agriculture by UNESCWA (2020) highlights that factors such as farmers' access and ability to use innovative technologies like ICT are critical to realising equity in the e-agriculture evolution accompanying the Fourth Industrial Revolution (4IR). Van Dijk and Hacker's framework pinpoints three key factors, namely the lack of material access, psychological access and usage access that cause a digital divide or inequality among people. Scholars such as Ballerini, Herhausen and Ferraris (2023) and Kiambi (2018) argue that ICT forms an integral part of these emerging technologies, making studies on ICT access and usage central to the digital divide and equity issues. The problem is whether South African rural small-scale farmers have access to necessary innovative technologies such as ICT tools, digital literacies and psychological access (regarding right perception) to enhance their farming activities and implement e-agriculture successfully in the contemporary digital era. Thus, this chapter investigates the digital divide in e-agriculture within the context of the 4IR, focusing on rural small-scale farmers in Raymond Mhlaba Local District Municipality (RMLDM), South Africa, as a pilot study. The chapter employs Van Dijk and Hacker's framework to assess RMLDM rural small-scale farmers' innovative technologies access and perception of e-agriculture technologies as a component to establish their readiness to adopt emerging innovative technologies that support agriculture to implement e-agriculture in the 4IR era.

For individuals and organisations to achieve effectiveness and efficiency and to operate optimally within the 4IR, they must apply ICT and utilise emerging technologies accompanying the various evolutions happening within the 4IR. Thus, a digital divide amid the 4IR hinders economic growth and development. The Food and Agriculture Organisation (FAO 2022) report revealed that small-scale farming sustains the livelihood of most developing nations' rural communities. Therefore, the sustainability of rural small-scale farmers is critical to developing nations' rural socio-economic development, and their digital exclusion in the era of 4IR will have serious consequences on developing nations' rural societies' food security and socio-economic development. This calls for a critical understanding of potential digital divide factors likely to cause a lack of digital opportunities, particularly among developing nations' rural small-scale farmers. Accordingly, in the case of the rural small-scale farmer, the knowledge of the various revolution happenings, access and ability to use the technologies associated with the revolutions is vital to their entrepreneurial growth in the 4IR. In this chapter, the author made use of the framework of digital access by Van Dijk and Hacker to design an assessment tool to determine access and perception as a component to give knowledge on digital equity issues based on empirical evidence from the part of selected rural small-scale farmers in RMLDM to adopt the emerging technologies associated with e-agricultural evolutions to understand the potential digital divide factors likely causing a lack of e-agriculture opportunity that is the ability to utilise emerging innovative technologies to enhance farming among RMLDM rural small-scale farmers. Van Dijk and Hacker's framework asserts that a lack of digital opportunity is created by three main factors: material, psychological and usage access. 'The Framework of Van Dijk and Hacker (2003)' section provides an overview of Van Dijk and Hacker's (2003) framework and its application in the investigation.

■ The framework of Van Dijk and Hacker (2003)

The framework of Van Dijk and Hacker (2003) assisted the researcher in identifying the key variables that needed to be examined to achieve the study's purpose. The three core factors of the framework and how they assisted the investigation are explained as follows:

1. A lack of material access is individual non-access to digital tools. This assisted the researcher in developing the research question (RQ):

    Do participants have access to any technologies?

2. The phobia of using digital tools or technologies emanates from an individual's lack of interest and unattractiveness of the new digital tools or technologies, which the authors termed psychological access. Assisted in coming up with RQs:

    Are participants willing to use the emerging technologies associated with the e-agriculture revolution, and what challenges can hinder their usage?

What knowledge exists among participants on technologies associated with e-agriculture?

3. According to the authors, the combination of material and psychological access leads to the third factor, usage access, which creates a lack of digital opportunities among individuals. Assisted in coming up with RQ:

   What are the perceptions of participants on e-agriculture technologies to enhance their farming activities?

The premise of the three identified factors by Van Dijk and Hacker (2003) that create a lack of digital opportunities among individuals guided the study assessment.

Guided by Van Dijk and Hacker's three factors that cause a lack of digital opportunities, the objectives of the investigation were to determine the farmer's awareness, access, perception, challenges and willingness to use emerging technologies associated with the e-agriculture revolution.

The rest of the chapter is organised as follows: Firstly, it provides a brief description of the need for individuals, businesses and rural small-scale farmers to be aware of, have access to, and use emerging innovative technologies to enhance their livelihoods in the contemporary digital era, as well as the identified research problem. To effectively establish the digital equity issues faced by rural small-scale farmers in RMLDM, it is essential to set specific research objectives and questions to gather empirical data for analysis and knowledge provision on the subject matter. Secondly, it outlines the research objectives and questions. Thirdly, it offers a literature review on the digital divide in developing countries, narrowing the focus to South Africa's situation. The need for ICT adoption in agriculture, discuss innovative technologies that support agricultural services and information delivery, and depict technological adoption among farmers is emphasised in developing countries, specifically in South Africa. Fourthly, it provides a brief overview of the South African agriculture sector, rural small-scale farmers and digital equity. Fifthly, it details how the Van Dijk and Hacker framework was applied, the approaches used to gather empirical data and the findings. Finally, it presents the chapter's conclusion and recommendations.

The 4IR is branded by the advancement of various innovations and their interdisciplinary application of ICT and computer science (Ballerini et al. 2023). Consequently, many revolutions, such as e-commerce and automation of business processes and productions, are happening within the 4IR, which presents several digital opportunities like the e-agriculture that individuals and businesses need to identify and take advantage of to realise growth, sustainability and higher productivity. E-agriculture is one of such emerging revolutions happening within the 4IR provoked by the application of ICT to support and enhance the agricultural sector (Malan 2018), presenting an array of digital opportunities that rural small-scale farmers can take advantage of to achieve sustainability and higher productivity in the 4IR. For developing nations, rural small-scale farmers need to take advantage of the various emerging digital opportunities such as e-marketing, automated irrigation technologies, tracking and remoting sensing technologies being created within the e-agriculture revolution, which require the farmers and agricultural entrepreneur's awareness of these emerging technologies associated with the many revolutions happening within the 4IR. The farmer's ability to utilise these emerging technologies to build capacity to realise efficiency, effectiveness and higher productivity is paramount in the 4IR.

The penetration of Internet coverage and ICT tools into the rural areas of the former black homelands has increased (South Africa State of ICT Report 2023) because of the South African government's effort to integrate communities found in the former black homelands into the mainstream economy of South Africa following the fall of the apartheid system. The former white communities have world-class infrastructure and are well-connected with the rest of the world regarding trade and technologies, while the same cannot be said about the former black communities (Bvuma & Marnewick 2020; Mbuyisa 2017). The work of scholars such as Garwe and Olwawale (2010), Mbuyisa (2017) and Oyelana and Thakhathi (2017) gives detailed accounts of how the apartheid system prevented communities found in the former black homelands from participating in mainstream economic activities of South Africa and how initiatives such as the rollout of Internet connectivity to former black homelands by the new democratic governments as efforts to integrate these areas to the mainstream economy of South African economy. However, the literature highlights challenges such as unequal access to necessary emerging technologies, cost, skills, tendencies to hold on to the old ways, and other factors that make only a few smallholder businesses (including small-scale farmers) and individuals based in these communities take advantage of the digital coverage expansion to build capacity to achieve growth in the digital age (Bvuma & Marnewick 2020). From the perspective of understanding how rural small-scale farmers within the former black communities are positioned to take advantage of the emerging technologies associated with e-agriculture, this study aims to investigate the awareness, access, perception, challenges and willingness of selected rural small-scale farmers in RMLDM to adopt the emerging technologies associated with the e-agricultural evolution to understand the potential digital divide factors likely causing a challenge for the rural small-scale farmers to take advantage of the e-agriculture opportunity to enhance their farming activities and livelihood so that necessary intervention can be implemented to assist the farmers enhance their productivity.

Data were gathered at RMLDM, based on Leedy and Ormrod (2014) and Takahashi and Araujo (2020). The findings from an appropriate case study about community members should not be limited to those specific individuals; rather, they should provide general insights into people within a community sharing similar characteristics. Because of the architecture of the former Homelands in South Africa, established under the apartheid regime, similar underdevelopment issues persist throughout the rest of the former Homelands. Also, Meijer et al. (2015) note that common socio-economic underdevelopment issues exist among deeply isolated rural communities in developing nations. Although this chapter focused on rural regions of the former homelands in Amathole District Municipality (ADM), the results may be similar to those of other rural regions of former homelands in South Africa. Again, from Meijer et al. (2015) assertion of similar underdevelopment issues confronting developing nations, the chapter results cannot be far from the experience or reality of deeply isolated developing nations' rural communities.

Objectives

The main objective of this chapter is to explore the inequalities experienced by South African rural small-scale farmers in their quest to access the necessary innovative technologies to enhance their farming activities and implement e-agriculture. In addressing this main objective, it was important to outline the participant's knowledge of the emerging technologies associated with e-agriculture. Understanding the farmers' perception of the use of e-agriculture technologies to enhance their farming activities was also critical.

The identified objectives were turned into four RQs as pointed out in the section 'Key questions'.

Key questions

The main questions addressed in this chapter that were identified to gather pilot data are presented as follows:

- What knowledge exists among participants on technologies associated with e-agriculture?
- What are the perceptions of participants on e-agriculture technologies to enhance their farming activities?
- Do participants have access to any technologies?

- Are participants willing to use the emerging technologies associated with the e-agriculture revolution, and what challenges can hinder their usage?

Literature review

According to Van der Waldt (2020), it is critical to describe what is said and done on the subject matter, as well as knowledge that assists in identifying the study concepts and constructs in this section. This section begins with a brief scholarly discussion on developing nations' rural small-scale farming, technologies and digital inequality. It briefly discusses the digital divide situation in developing nations and South Africa.

Mazzarol (2015) points out that the digital age presents no choice for smallholder business entrepreneurs to integrate technologies to enhance their business operations and processes. Awuor and Rambim (2022) assert that ICT helps remote farmers gather well-informed market information to sell their farm produce. Misaki (2021) reveals that applying ICT and social media in rural farming is vital to food production as it assists rural farmers in sharing and exchanging farming knowledge and information over a wider geographical range. According to Mendes et al. (2020) and Inwood and Dale (2019), a systematic review of the literature on mobile apps for precision and sustainable agriculture reveals that there exist various mobile apps, for instance, to detect crop and farm animal diseases, but whether rural small-scale farmers are aware of them and possess the necessary skills to use them remains unanswered. This study aims to contribute knowledge on rural small-scale farmers found in RMLDM former black rural communities' digital inequalities and suggest recommendations thereof.

The digital divide in developing nations and the South African situation

Opp (2021) explains the digital divide as the gap between regions and individuals with access to the Internet and modern ICT and those without such access. Opp (2021) further highlights that the digital divide manifests in various ways, including financial ability, technological skills, age differences, educational disparities, the distinction between developed and developing nations, urban versus rural areas and gender disparities.

The World Economic Forum (2022) indicates that non-use and non-access to technologies in African nations have isolated most African nations' populations from the swiftly prime means of communication and commerce. This is echoed in the International Telecommunication Report

(International Telecommunications Union [ITU] 2023), which reveals that many African nations' rural populations are offline.

In South Africa, according to the South Africa State of ICT Report (2023), there is a high digital divide between the white and the black race because of the past apartheid system, which prevented the black race from participating in any mainstream economic activities. This chapter, therefore, provides empirical evidence to reveal in practical ways the digital inequality among the former black rural communities and recommends some solutions to bridging the gap.

Some specific areas in rural small-scale farming that need information and communication technology application enhancement

Literature attests (Barakabitze et al. 2017; Gwaka 2017) how ICT application enhances information and knowledge sharing in the contemporary digital age. The following discussion highlights the disadvantages rural farmers face because of existing digital inequalities among them.

Information can be considered a farming input (Sanusi, Omokhudu & Adeloye 2018) because farmers depend on information to make strategic decisions. For instance, small-scale farmers in isolated rural areas depend on rain for farming decisions, which calls for information on the rain season's expectations to decide when to plant seeds. Therefore, developing nations' deeply isolated rural small-scale farmers' timely access to information is vital to their productivity (Manteaw 2020). Fosu and Van Grenuen (2022) highlight that farmers, in general, require information to make strategic decisions in each stage of the three farming stages:

1. In the pre-cultivating stage, the farmer makes critical farm input decisions, like the crop type and when to plant.
2. Farmers must apply management skills to oversee cultivation, diseases and pest control during the farming process management stage.
3. The harvest/post-harvest stage is where the farm products are harvested and processed for the target markets.

Accordingly, Adio et al. (2016) emphasise the importance of farmers accessing information such as the latest knowledge on seed adaptability and pest and disease management on time to make critical farming input decisions. The dawn of the digital era, catapulted by ever-evolving technologies, has postulated ICT applications as the cardinal and reliable means of delivering information. The features of ICT tools like social media platforms include the ability to capture information in video, audio and text formats. Within seconds of posting the information, it can be accessed across the globe, making the application of ICT essential to the timely delivery of the latest agricultural knowledge to farmers, irrespective of their geographical location. Pesce et al. (2019) highlight that the use of technologies by small-scale farmers boosts their production capacities and reduces their production costs. Krone and Dannenberg (2018) indicate that adopting digital technologies is vital to resolving the spatial problems between developing nations and deeply isolated rural small-scale farmers and urban markets. Thus, rural small-scale farmers not receiving critical agricultural information and knowledge on time to enhance their productivity in the digital age will remain a challenge if digital inequalities among rural small-scale farmers are not properly monitored and addressed accordingly. The productivity of South African rural small-scale farmers found in former black rural communities will continue to be hindered (Abegunde, Sibanda & Obi 2020; Nwafor, Ogundeji & Van der Westhuizen 2020).

Some innovative technologies that support agricultural services and information delivery

Food and Agriculture Organisation (2017) points out that agricultural knowledge sources combine indigenous knowledge and scientific research. After the knowledge is created, it must be disseminated to the users. Information and communication technology is a vital tool in the digital age for promoting efficient and cost-effective knowledge management and fast knowledge sharing. According to Chhachhar et al. (2014), ICT has capacities when properly joined in new configurations. Information and communication technology has become an adaptable tool for gathering, sharing and transferring knowledge for the development of developing nations' rural areas and agriculture. Consequently, the application of ICT is a key player in e-agriculture because of its ability to network and facilitate knowledge sharing among the various sectors within agriculture. This section highlights some of the ICT innovations used to support agriculture.

The world wide web technologies

Since the emergence of the Internet, there has been a combination of technologies and conventional methods of disseminating information (ITU 2023). The world wide web (WWW), the net, embodies capabilities such as video, audio, text and picture formats to share information globally. According to FAO (2020), the net has significantly influenced farmers' decision-making processes and supported agriculture in many ways. The application of the net and various ICT tools has enabled the development of initiatives and innovative technologies such as Esoko, MFarmer Mobile App and many others across the globe to develop rural small-scale farmers' capacity. In South Africa, the Agricultural Research Council (ARC) Hub App developed by the South African Government through the South African ARC provides all-around agricultural information to farmers, agricultural extension agents and researchers (CSIR 2022).

Digital cameras

According to Berthe (2015), digital cameras are being used to support agriculture extension services. Using digital cameras, extension services personnel can record video messages and pictures and share them with farmers via email, social media and instant messaging. Also, rural small-scale farmers can interact with subject matter specialists on issues they face with their farming activities (Mabe 2011). Coleman (2023) reveals that stock theft is a huge challenge facing South African farmers. Using innovative technologies like closed circuit television (CCTV), which combines ICT and digital cameras to monitor the surrounding environment, will enable rural small-scale farmers to prevent the theft of farm animals from increasing production.

Automated, e-marketing and remote sensing technologies

E-marketing, decision support systems (DSS), management information systems (MIS), automated irrigation systems (AIS), soil monitoring devices (SMD), tracking devices (TD), CCTV and geographic information systems (GIS) are some of the emerging innovative technologies accompanying e-agriculture (FAO 2017) to support farming activities in the digital age. Through these technologies, rural small-scale farmers can effectively manage the three stages of farming to achieve higher productivity. Also, as part of the solution to the challenge, Shemfe (2018) raised the issue that South African rural small-scale farmers are confronted with accessing big markets to sell their produce, which can be solved using e-marketing.

Technological adoption among developing nations' farmers

A study was conducted among rural small-scale farmers in Tanzania by Lubua and Kyobe (2019) to determine the farmers' adoption of technologies to enhance their farming activities and establish that peer influence and purchasing power determine their intention to adopt ICT.

The work of Freeman and Mubichi (2017) shows that Mozambique rural small-scale farmers adopt technological devices such as television, mobile phones and radio to access agricultural information. In Zimbabwe, a study by Gwaka (2017) reveals that the rural Beitbridge livestock system does not utilise digital technologies. Shiferaw et al.'s (2015) work reveals Uganda's rural small-scale farmers' lack of adoption of innovative technologies like ICT. The use of conventional ICT devices like television and radio by rural small-scale farmers found in Mahikeng Local Municipality of South Africa is shown in the work of Shemfe (2018). Atsriku (2020) reveals that rural small-scale farmers' adoption of agricultural technologies in Ghana's Adumase community depends on multiple indicators, such as socio-economic and institutional influence. Kiambi (2018) and Barakabitze et al. (2017) highlight that the low adoption of ICT among most African rural small-scale farmers is influenced by poor ICT infrastructure. In their works, Shemfe (2018) highlights that the challenge of finance and lack of skills are major contributors to rural farmers in South Africa's inaccessibility to innovative automated and remote sensing devices to support their farming activities.

Agriculture and economic growth contributions

The Digitalisation of Africa Agricultural Report (2019) reveals that many African developing nations' subsistence farming practices rely on men and animal power and are not sustainable. Three standards, namely non-disturbances of the natural ecosystem, economic viability and the reduction of exploitation of agricultural workers, according to the Food and Agriculture Organisation (FAO 2020), constitute sustainable farming in agriculture. However, agricultural scholars such as Adenle, Azadi and Manning (2017) and Nyiawung, Suh and Bishwajit (2019) have highlighted developing nations' farming practices, like cutting down trees and convectional livestock grazing, which contribute to desertification and loss of biodiversity. More so, many developing nations' deeply isolated farming productions are for household consumption, and few are sold, making most developing countries' agricultural practices unsustainable.

The agricultural sector contributes to many developing nations' gross domestic production (World Bank Report 2024). Thus, the agriculture sector is seen as one of the critical sectors that can be used to improve livelihoods and eradicate poverty in most developing countries. This notion is laid out in the World Bank Report (2024), which points out that in 2016, 65% of global poor working adults' livelihood was out of the agricultural sector. The sector also serves as a supplier of bulk basic food and a source of income for most developing countries' rural populations (Lal 2015; Thome et al. 2021).

A brief overview of the South African agriculture sector, rural small-scale farmers and digital equity

The contribution of the South African agriculture sector to the nation's total export earnings in 2021 was estimated at 10.7 billion dollars (Goldblatt 2021). South Africa's climate condition presents an opportunity for farming and production of various grains, wool, mohair, wine, fruits and dairy products (Nwafor 2019; Taruvinga, Visser & Zhou 2016). Much of the work of researchers such as Nwafor (2019) and Sihlobo (2019) has shown great potential for rural small-scale farmers in South Africa. However, the South African farming sector is dominated by white farmers who use advanced technologies to support their farming activities (Stats SA 2020; Shemfe 2018). Although the South African State of ICT Report (2020) reveals an increase in ICT and Internet access in the former black areas, the literature demonstrates a challenge of the use of ICT by small-scale farmers found in the rural areas of the former black communities to enhance their farming activities (Abegunde et al. 2020; Nwafor et al. 2020).

Raymond Mhlaba Local Municipality (RMLM) is one of the six local municipalities that constitute ADM and RMLM is considered the largest inhabiting up to a third of ADM landscape, making the municipality the largest in ADM. Its major towns are Adelaide, Alice, Bedford, Fort Beaufort, Hogsback, Middledrift and Seymore. The municipality houses most of the imposing and majestic mountain ranges in ADM. Raymond Mhlaba Local Municipality's economic growth stems from the agricultural activities of the area (Gqabi 2020). Thus, enhancing RMLM farmer's productivity is critical to RMLM socio-economic development efforts.

Approaches employed to gather empirical evidence

The chapter explores the farmers' awareness, access, perception, challenges and willingness to use emerging technologies associated with the e-agriculture revolution. Quantitative approaches in open and closed-ended questionnaires were deemed suitable for collecting the data (Creswell & Creswell 2018). The author adopted a purposive sampling technique for selecting the participants. According to Creswell and Creswell (2018), a purposive sampling approach is an approach where the researcher uses their subject matter knowledge to select respondents who will provide in-depth information to answer the RQs adopted by the researcher to approach small-scale farmers in rural areas of Adelaide, Alice, Bedford, Fort Beaufort, Hogsback, Middledrift and Seymore who were willing to be part of the study. The questionnaires were self-administered to the farmers on a suitable date. This created an opportunity for the researcher to clarify any difficulty and misunderstanding of the questions on the questionnaire. The author managed to secure 46 respondents for the study.

Results and discussions

The results of the chapter are presented in this section according to the following question:

> What knowledge exists among participants on technologies associated with e-agriculture?

Senyolo et al. (2018) reveal that farmers' perceived gains from the technology in question influence their uptake and use. From this perspective, the author assessed participants' knowledge of emerging technologies associated with e-agriculture. Table 6.1 presents the findings.

The conclusions from Table 6.1 reveal a low level of emerging technologies associated with e-agriculture awareness in the study participants. For instance, 72% indicated they were unaware of e-marketing technologies used to sell their products. The electronic commerce (e-commerce) revolution emerged because of the application of ICT to support business processes, paving the way for business transactions to be conducted via online processes (Ramdansyah & Taufik 2017). Consequently, using social media platforms, for example, allows individuals to market, sell and buy products online, irrespective of the individual geographical location. Agricultural scholars like Nwafor et al. (2020) have highlighted the challenge of market access for smallholder farmers in South Africa. Therefore, the use of e-marketing technologies and strategies by small-scale farmers in South Africa is critical for their sustainability and growth in the 4IR. The findings indicate low e-marketing awareness among the study participants, which requires urgent attention from the RMLM sector responsible for promoting rural agriculture. This is crucial because e-marketing can significantly contribute to the growth and sustainability of rural small-scale farming in the study areas.

TABLE 6.1: Knowledge of participants on e-agriculture.

Statement	Yes (%)	No (%)
I am aware of e-marketing technologies to sell my farm products	28	72
I am aware of e-agriculture technologies like SMDs, TDs, GIS, etc., that can assist me in monitoring soil conditions and tracking farm animals	11	89
I am aware of e-agriculture technologies like DSS and MIS that can assist me in managing my farming activities and decision-making	7	93

Source: Author's own work.
Key: SMD, soil monitoring devices; TD, tracking device; GIS, geographic information systems; DSS, decision support systems; MIS, management information systems.

What are the perceptions of participants on e-agriculture technologies to enhance their farming activities?

As highlighted by Kante, Oboko and Chepken (2019), farming is a functioning of production, and as such, each stage of the production process requires specific production inputs. Thus, to achieve higher productivity at the end of the production process, the farmer must apply skills and the right tools to manage each production stage effectively. Various technological innovations are emerging within the 4IR to assist farmers in managing the production processes effectively (Digitalisation of Africa Agriculture 2019). However, the works of agricultural scholars such as Musa, Githeko and El-Siddig (2014), Mubichi (2017) and FAO Report (2017) reveal that there is a disjoint between innovative and research outputs, farmers' practices and their adoption of modern technologies to enhance productivity. According to Abegunde et al. (2020) and Kante et al. (2017), perceived gain from adopting a technology influences farmers' adoption decisions. From this perspective, the chapter assessed to determine the farmer's perception of e-agriculture technology. The findings are presented in Table 6.2.

The conclusions from Table 6.2 show that 48% of the farmers believed that e-agriculture technologies can improve their farming activities. This indicates that most farmers will receive interventions to assist them in using e-agriculture technologies to enhance their productivity.

Do participants have access to any technologies?

Lack of access to technology is considered a digital divide (Opp 2021). Participants were guided by a list to determine the e-agriculture technologies they could access. According to Coleman (2023), stock theft is one of the major issues confronting farmers in stock farming in South Africa.

TABLE 6.2: Perception of participants on e-agriculture.

Statement	I agree (%)	I do not agree (%)	Not sure (%)
I believe the use of e-agriculture technologies can enhance my farming activities	48	27	25
I believe the use of e-agriculture technologies can assist me in making informed decisions on critical matters of farming	29	40	31
I believe the use of e-agriculture technologies can assist me in increasing my market reach	42	20	38
I believe the use of e-agriculture technologies can assist me in protecting my farm	19	53	28

Source: Author's own work.

Using e-agriculture technologies such as TDs and CCTV cameras can assist stock farmers in protecting their farm animals from thieves. Table 6.3 gives the findings of participants' access to e-agriculture technologies.

The conclusions indicated 100% ownership of mobile phones followed by 22% ownership of laptop/personal computers. There was low ownership of websites (2%), TDs (3%) and CCTV cameras (14%). These results support Dyck and Silvestre's (2019) assertion that small-scale farmers in low-income countries use modest and obsolete technologies.

Are participants willing to adopt e-agriculture technologies? And if not, what are the reasons?

According to Van Dijk and Hacker (2003), non-willingness and phobia of using technology by an individual creates a digital divide. Participants were asked to indicate their willingness if allowed to use e-agriculture technologies and give reasons if they were not willing. Table 6.4 presents the results.

Most participants (71%) indicate their willingness to use e-agriculture technologies if given opportunities. Of the 29% of participants who indicated their non-willingness to use e-agriculture technologies cited reasons such as affordability, issues of maintenance and lack of skills to operate, to name a few, as their reasons.

TABLE 6.3: Access to technologies.

Type of technology devices	Ownership (%)
Mobile phone	100
Laptop/personal computers	22
Tablets	12
Websites	2
Mobile phone with camera/video facility	89
Tracking devices	3
CCTV	14

Source: Author's own work.
Key: CCTV, closed circuit television.

TABLE 6.4: Participants' willingness to use e-agriculture technologies.

Statement	Yes (%)	No (%)
Willing to use e-agricultures if given the opportunity	71	29
Given reasons for non-willingness to use (in common themes)		
• Because of non-stable electricity and Internet connectivity • Because it is expensive to buy and maintain them • I do not have the skills to operate them		

Source: Author's own work.

The World Bank Report (2020) considers the agricultural sector vital to boost economic development in most developing nations. As a result, efforts should be made to transform small-scale farming activities and agro-based processing, especially to realise higher productivity. Literature highlights that most developing nations struggle to achieve higher productivity and efficiency in agriculture. For instance, the Digitalisation of Africa Agriculture Report (2019) highlights that agricultural success stories in most developing nations, especially Africa, have not been uniform. Matusso, Mugwe and Mucheru-Muna (2014), Nyiawung et al. (2019) and Bjournlund, Bjournlund and Rooyen (2020) highlight that although South Asia has been seeing cereal production increasing by more than 50% as well as poverty declining by 30% in recent years, case of sub-Saharan Africa remains unaltered in cereal yields and poverty rates. Therefore, to fight poverty in sub-Saharan Africa and developing nations, investment in the agriculture sector is vital, considering its capabilities of empowering and providing income for most developing nations' populations. Thus, the current chapter findings provide knowledge on how best to assist rural small-scale farmers in effectively and efficiently using emerging technologies accompanying e-agriculture to achieve efficiency and higher productivity, thereby assisting in achieving food security among rural communities.

Scholars such as Chizema (2023) and Malan (2018) have voiced the vital need for tailor-made initiatives by developing countries' governments to empower small-scale farmers, particularly those in rural areas. The results call for initiatives such as the development of information systems platforms that can run easily on mobile phones, which is more accessible to the farmers to assist the farmers in planning their farming activities, managing their resources and providing information on markets as a step to rollout e-agriculture among the farmers.

■ Conclusion

The issue of empowering developing nations' rural small-scale farmers to take advantage of the digital opportunities presented by the various revolution happenings within the 4IR cannot be over-emphasised because of the vital contributions of rural small-scale farming to developing nations' rural socio-economic development. The current chapter sheds light on potential factors causing a lack of e-agricultural digital opportunities among selected RMLM rural small-scale farmers amid the e-agricultural revolution. The empirical results revealed:

- A low awareness of the emerging technologies accompanying the e-agriculture revolution among the selected farmers.

- A total of 29% of the selected farmers indicated that they are unwilling to use agricultural technologies if given the opportunity.
- Affordability and lack of skills to operate the technologies are some of the reasons for not being willing to use e-agriculture technology.

Therefore, creating e-agriculture digital opportunities among the study area's small-scale farmers will require an effort from the RMLM sector overseeing rural agriculture development to develop strategies to address the identified variables causing a digital divide among the farmers. The following strategies can be used to address the identified variables:

- Enhancing the farmer's digital skills to operate or use technology effectively is critical; thus, digital skills training programmes can be developed to assist the farmers.
- Most of the farmers have mobile phones. The farmers can be workshopped about the benefits of selling their farm produce online (e-marketing) and, as a starting point, encourage them to open social media accounts to showcase their farm produce.
- There is a need for RMLM to partner with Internet and mobile service providers to improve connectivity within RMLM rural areas, as this prevents the farmers from using technology.

Further studies are critical for examining farmers' communication structures and how they impact ICT usage.

Additionally, following the shift from education to agriculture in the previous chapter, the next chapter addresses another sector that affects South Africa: the health sector and digital inequalities within this sector have been highlighted.

Chapter 7

Addressing digital inequality in rural primary healthcare systems in sub-Saharan Africa

Olukayode Oki
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Jose Lukose
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Abstract

This chapter explores digital inequality within rural primary healthcare systems across sub-Saharan Africa. It examines disparities in access to digital healthcare technologies and their impact on healthcare outcomes while proposing strategies to mitigate digital inequality. The chapter addresses socio-economic, infrastructural and policy-related factors contributing to the digital divide in African healthcare through a comprehensive review of historical contexts, empirical studies and expert insights. Understanding the historical context is crucial for grasping the evolution of healthcare delivery

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models and policies, as it examines colonial legacies, political transitions, and economic fluctuations. These factors highlight their lasting impact on rural healthcare systems. The emergence of digital health technologies presents both promises and challenges in the pursuit of universal healthcare. The chapter's objectives include analysing the consequences of digital inequality on health outcomes, such as delayed access to information, limited telemedicine services, and disparities in technology-enabled diagnoses. It also examines the economic implications, detailing how digital inequality perpetuates cycles of poverty and hinders overall economic development in rural areas. Looking towards the future, the chapter explores emerging technologies like artificial intelligence in diagnostics, emphasising long-term sustainability and lessons from technology adoption in developed nations. It encourages stakeholders to adopt strategies informed by technological advancements rooted in the region's historical and cultural fabric. This approach ensures effective and sustainable interventions for equitable healthcare access in sub-Saharan Africa.

■ Introduction

The African continent, home to diverse cultures, languages and landscapes, grapples with a profound healthcare anomaly. While strides have been made in improving healthcare access, rural areas face persistent challenges exacerbated by digital inequality (Fennelly et al. 2020). Digital inequality, resource-constrained healthcare systems and the shortage of digitally literate personnel compound existing disparities hindering the achievement of universal healthcare (Mbunge, Muchemwa & Batani 2022).

The historical context of healthcare in Africa reveals a trajectory shaped by colonial legacies, political upheavals and economic fluctuations. Rural communities, often characterised by limited infrastructure, sparse resources and a shortage of healthcare professionals, bear the brunt of systemic challenges (Al-Rayes, Alumran & Alfayez 2019; Amoroso et al. 2010). Against this backdrop, the integration of digital health technologies emerges as both a promise and a source of contention.

Understanding the historical evolution of the African healthcare system is pivotal in unravelling the challenges that digital inequality seeks to address (Boonstra, Versluis & Vos 2014; Furusa & Coleman 2018). Colonial histories, marked by exploitation and resource extraction, negatively impacted healthcare infrastructure and accessibility. The post-colonial era witnessed struggles for independence, leading to political and social changes that, in turn, influenced healthcare policies and delivery models.

Rural areas, often marginalised in the allocation of resources, witnessed slow progress in healthcare development (Isemeck et al. 2019). The trajectory of healthcare in Africa is a tapestry woven with triumphs, setbacks and persistent challenges. Digital health technologies, as a relatively recent entrant, intersect with this historical narrative, introducing both opportunities for transformation and new layers of complexity.

The 21st century ushered in a digital revolution with transformative implications for healthcare (Giansanti 2023). Digital health technologies, encompassing telemedicine, electronic health records (EHRs), mobile health applications and more, promise to bridge gaps, enhance efficiency and democratise healthcare access (Adenuga, Iahad & Miskon 2020). However, these promises encounter roadblocks when applied to rural settings in Africa.

The digital divide, a global phenomenon, manifests uniquely in the African context (Mechael et al. 2010). While urban areas witness a surge in technology adoption, rural communities often lag behind. The reasons are myriad, ranging from limited infrastructure to socio-economic disparities and cultural considerations (Hage, Roo & Van-Offenbeek 2013). Gray et al. (2011) explain that the most important part of service delivery is the availability and quantity of resources and the quality of care being received. It is vital to effectively capture clinical data to ensure quality, safe and sustainable healthcare service delivery. However, because of digital inequality between rural and urban areas, the quality of healthcare received in rural areas is still low (Archer et al. 2021). Despite numerous studies on the digital implementation and enhancement of primary healthcare to ensure quality services, significant disparities still exist between rural and urban areas in Africa. Therefore, examining the slow adoption and implementation of digital healthcare systems in rural regions is essential. This chapter seeks to analyse these challenges, explore their historical origins and outline a practical approach to bridging the digital divide in the rural primary healthcare system. To achieve this chapter's aim, the following objectives were explored:

- Uncover the multifaceted dimensions of digital inequality in rural primary healthcare systems in Africa, recognising the uniqueness of each context.
- Analyse the consequences of digital inequality on healthcare outcomes and the socio-economic fabric of communities, emphasising the need for a holistic approach.
- Propose evidence-based strategic interventions, practices and policy recommendations for mitigating digital inequality, acknowledging the importance of context-specific and unique challenges rural healthcare systems face.

The remainder of this chapter is organised as follows: firstly, it presents the landscape of digital inequality in the healthcare sector of rural sub-Saharan Africa. Secondly, it outlines the consequences of digital inequality in these areas. Thirdly, it discusses how the healthcare inequality gap in rural Africa can be addressed. Fourthly, it presents future directions for research and interventions from both the public and private sectors. Finally, the chapter concludes.

The landscape of digital inequality in rural healthcare

Digital inequality in rural healthcare is a multifaceted issue. It spans a spectrum of basic access to advanced digital literacy (Adetoyi & Raji 2020). This section explores the depth and breadth of these disparities, considering factors such as digital literacy, connectivity, device availability, the ability to effectively use digital tools and the overall integration of technology into healthcare systems. Digital inequality also encapsulates variations in access to information, the ability to navigate and interpret digital health resources, and the degree to which communities can actively engage with technology for health-related purposes.

The historical legacy of colonialism and post-colonial developments has shaped regional dynamics, influencing the distribution of resources, infrastructure development and access to primary healthcare. The disparities in historical development, economic activities and political landscapes between regions have far-reaching implications for the state of healthcare and digital infrastructure (Agyepong et al. 2018). Recognising and understanding these regional dynamics is pivotal for designing interventions tailored to the specific needs and challenges of different parts of the continent.

In South Africa, the colonial legacy has perpetuated racial segregation and disparities in the healthcare system, leading to racism and geographic disparities, with a disproportionate focus on tertiary care while deprioritising primary healthcare (Ordóñez et al. 2023). Furthermore, the urbanisation of post-colonial Africa has posed threats to human security, with challenges in coordination, structural violence and gaps in policy implementation (Mudenda et al. 2022). The healthcare systems in Africa have faced significant challenges post-colonisation, particularly exacerbated by the recent coronavirus disease 2019 (COVID-19) pandemic. The vulnerability of African healthcare systems has been further exposed, revealing inadequacies and constraints in the supply chain for medical products and technologies (Ejekam et al. 2023). Furthermore, Africa comprises mostly developing countries with poor healthcare systems and low health literacy, making it susceptible to catastrophic healthcare system failures even under modest pressure (Oleribe et al. 2019). These studies collectively underscore the enduring impact of colonisation on African healthcare systems, highlighting the need for culturally sensitive care, addressing historical racism and prioritising primary healthcare to improve health equity for African populations. These studies also provide a comprehensive understanding of the challenges faced by African populations in accessing healthcare services and the enduring impact of colonisation on healthcare systems.

Causes of digital inequality in rural healthcare

Socio-economic determinants have historically shaped access to resources, healthcare, education and opportunities. Understanding the roots of economic disparities provides insights into how income levels, education and occupation contribute to differential access to digital healthcare systems.

The historical trajectory of income disparities has profound implications for digital inequality in rural healthcare. Colonial economic structures, primarily designed to extract resources, contributed to the concentration of wealth in urban areas (Al-Aswad et al. 2013). This historical legacy has disadvantaged rural areas economically, limiting their capacity to invest in digital infrastructure and healthcare technologies (Asangansi & Braa 2010). Tracing the evolution of income distribution policies, or lack thereof, sheds light on the persisting economic inequalities that underpin digital disparities.

Access to education is a pivotal factor influencing digital literacy and the ability to engage with digital healthcare solutions. The historical context of education in rural Africa reveals disparities in educational opportunities between urban and rural areas (Jayawardena & Ratnayake 2015). Historical educational policies, from colonial-era limitations on educational access to post-colonial efforts to address educational disparities, have shaped the current landscape (Borycki et al. 2011). A historical analysis of educational investments and policies helps identify critical junctures where interventions could have mitigated the digital divide.

Occupational patterns and the evolution of employment opportunities in rural areas contribute significantly to digital inequality (African Development Bank 2020). Historical shifts in economic activities, from traditional agrarian practices to emerging sectors, shape the occupational landscape. Analysing the historical transitions in rural economies provides insights into the types of occupations that have historically dominated these regions. Understanding these patterns is crucial for devising strategies that align with rural communities' skill sets and occupational needs, ensuring that digital healthcare solutions are contextually relevant.

Infrastructure, a cornerstone of technological integration, has historical underpinnings that influence the contemporary digital landscape. The challenges, such as limited Internet connectivity and power supply issues, illuminate how infrastructure deficits pose barriers to digital inclusion in rural healthcare.

The historical development of telecommunication infrastructure is a key determinant of digital connectivity in rural healthcare. The evolution of telecommunication networks, from early landline systems to the expansion of mobile networks, shapes the contemporary challenges of limited Internet connectivity in rural areas (Aldredge et al. 2020). Historical investments in telecommunications, influenced by economic and political considerations, have implications for the existing digital divide. Examining the historical rollout of communication infrastructure provides insights into the persisting challenges and points of intervention for improving Internet connectivity in rural healthcare.

The challenges associated with power supply are integral to understanding the infrastructural barriers hindering the adoption of digital healthcare technologies. Historical reliance on non-renewable energy sources and challenges extending power infrastructure to remote areas have longstanding implications. Analysing the attempts to address power supply issues, such as electrification projects and renewable energy initiatives, informs strategies for overcoming these challenges. A historical perspective sheds light on the causes of power-related barriers and potential solutions to ensure the sustainable integration of digital health technologies.

The historical trajectory of technology infrastructure development in rural areas is pivotal for understanding the existing gaps. Historical policies related to technology deployment, rural electrification initiatives and the establishment of technology hubs offer insights into the challenges faced in building and maintaining the technology infrastructure (Katurura & Cilliers 2018). Examining historical successes and failures in technology infrastructure projects provides a roadmap for devising strategies aligned with the historical context. It helps identify critical junctures where interventions can enhance the resilience and sustainability of technology infrastructure in rural healthcare.

Several potential solutions can be considered to address the infrastructural challenges of digital inequality in the sub-Saharan African continent's primary healthcare system. Firstly, the adoption of digital health technologies has been identified as a means to improve healthcare delivery in Africa (Ibeneme et al. 2022). However, challenges such as poor coordination of pilot projects, weak healthcare systems and infrastructure limitations hinder the deployment of digital health technologies (Olu et al. 2019). Additionally, mobile health (mHealth) projects have shown the potential to address the problems faced by healthcare systems in Africa, such as poor management of drug stocks and weak surveillance systems.

Furthermore, the deployment of universal digital health interventions, including smartphone apps and online primary care services, can help measure digital inequality across a nation (Zhang et al. 2023). Moreover, implementing a decentralised approach, such as the district healthcare system has been proposed as a practical strategy to achieve Universal Health Coverage (UHC) in South Africa.

This approach emphasises the need for minimal universal coverage and positive discrimination to bridge health disparities. Additionally, the role of Traditional, Complementary and Alternative Medicine (TCAM) in providing primary healthcare services has been recognised in some sub-Saharan African countries' health policy documents, particularly in areas with limited access to essential health services (James et al. 2019). Furthermore, the adoption of digital technologies has the potential to improve the performance of key healthcare business processes, particularly those that can be simplified with information technology. However, challenges such as economic and digital divides present significant obstacles to scaling technology for healthcare in regions like sub-Saharan Africa (Ware 2022). Additionally, lessons learnt from developing, evaluating and implementing digital solutions in the healthcare system can provide valuable insights into successful digital health-integrated work programmes (Hourani et al. 2021).

In conclusion, addressing the infrastructural challenges of digital inequality in the primary healthcare system of the African continent requires a multifaceted approach. This includes leveraging digital health technologies, addressing infrastructure limitations and integrating traditional and alternative medicine practices into the healthcare system. Additionally, implementing decentralised approaches and the lessons learnt from digital health programmes can contribute to achieving UHC and improving healthcare delivery in Africa.

Cultural and behavioural factors

Cultural beliefs and behaviours have shaped healthcare practices for centuries (Kesse-Tachi, Asmah & Agbozo 2019). This section conducts a historical analysis to unravel the intricate relationship between culture and technology adoption. Understanding historical perspectives makes it possible to design culturally sensitive approaches that address the root causes of resistance to digital healthcare solutions.

Cultural attitudes towards technology adoption have historical roots that significantly influence the current landscape of digital healthcare disparities. Historical instances of resistance to technological innovations, often rooted in cultural beliefs and practices, provide insights into the challenges faced in promoting digital health solutions (Portz et al. 2019). For example, in many sub-Saharan African communities, traditional medicine has deep cultural roots and remains a trusted source of healthcare. Traditional healers are significant in community health in countries like South Africa, Nigeria and Ghana. The reliance on traditional practices can create resistance to adopting digital health technologies, which are seen as foreign and incompatible with local practices. Also, cultural beliefs can shape attitudes towards modern healthcare interventions. For example, during the Ebola outbreak in West Africa, there was significant resistance to modern medical interventions, partly because of cultural beliefs about illness and death. This resistance extended to digital health tools used for tracking and managing the outbreak. In Sierra Leone, Guinea and Liberia, mistrust of health workers and digital tools impeded efforts to control the disease, as the World Health Organization reported.

Exploring historical narratives surrounding technology adoption, including successes and failures, helps identify patterns and develop culturally sensitive strategies (Odekunle, Srinivasan & Odekunle 2018). Understanding how cultural factors influence the acceptance or rejection of technology informs the development of targeted interventions that align with cultural norms.

The relationship between communities and healthcare systems shapes the level of engagement with digital healthcare technologies. Examining historical healthcare practices, community-led initiatives and traditional healing methods offers insights into community preferences and expectations regarding healthcare (O’Mahony et al. 2014). Understanding historical interactions between healthcare providers and communities helps identify points of trust and mistrust. It provides a foundation for designing community-centric digital healthcare solutions that resonate with the historical context, fostering greater acceptance and participation.

The ‘Consequences of digital inequality in rural healthcare’ section explores how digital inequality affects healthcare outcomes and the socio-economic fabric of rural communities. Understanding these consequences is crucial for developing targeted interventions to address the root causes of digital disparities in rural healthcare.

Consequences of digital inequality in rural healthcare

Drawing on empirical evidence, this section investigates how digital inequality translates into tangible healthcare disparities. Beyond broad strokes, it delves into specific health outcomes, exploring issues such as delayed diagnoses, limited access to healthcare information and overall impacts on health status.

Fragmentation within health information systems (HISs) is a critical impediment to effective healthcare delivery. The absence of a standardised approach to data collection, storage and retrieval leads to siloed information, hindering comprehensive patient care. The authors examine how the various components of HISs frequently fail to communicate effectively, leading to fragmented patient records and incomplete medical histories.

Interoperability challenges pose a substantial barrier to the integration of diverse healthcare platforms. Electronic health records, diagnostic tools and monitoring devices often operate in isolation, limiting the exchange of vital patient information. The discussion explores how the lack of interoperability hampers the fluidity of healthcare services, contributing to inefficiencies and suboptimal patient outcomes.

Telemedicine's potential to bridge geographical gaps is hampered by inadequate access to robust telecommunication infrastructure. The chapter investigates how the absence of high-speed Internet and reliable connectivity in remote areas impedes real-time communication between healthcare providers and patients. The discussion also addresses the challenges posed by the limited bandwidth in transmitting medical data, affecting the quality and effectiveness of remote consultations. Building and maintaining trust in remote healthcare interactions is nuanced. The chapter explores how cultural factors, communication barriers and the absence of face-to-face interactions contribute to challenges in establishing the trust essential for effective doctor-patient relationships. It also emphasises the need for tailored approaches in digital health solutions that consider cultural nuances and sensitivities specific to rural communities.

Economic implications

Examining the economic consequences of digital inequality goes beyond theoretical frameworks. This section explores how digital disparities can reinforce existing socio-economic inequalities and hinder economic development within rural communities. It considers the broader financial ecosystem and the potential for digital interventions to act as catalysts for positive change.

- *Cycle of poverty*: Digital inequality in rural healthcare has enduring economic consequences, contributing to a cycle of poverty. Limited access to digital health technologies hampers healthcare outcomes, increasing healthcare costs and productivity losses. Analysing historical economic trends in digitally underserved rural areas provides insights into the persistent poverty cycle. Understanding the historical economic impact of healthcare disparities helps identify root causes and potential interventions. Examining historical instances where targeted healthcare interventions contributed to economic development offers lessons for breaking the cycle of poverty through equitable access to digital healthcare technologies.

- *Hindrance to economic development*: Digital inequality affects individual households and hampers broader economic development in rural areas. The historical context of economic development initiatives and their interaction with healthcare disparities inform strategies to align healthcare interventions with broader development goals.

Analysing historical economic development projects in digitally underserved regions helps identify missed opportunities and successful models. Understanding the historical interplay between healthcare and economic development provides a foundation for developing integrated strategies addressing health and economic disparities.

The section 'Bridging the gap: Strategies for digital inclusion in rural healthcare' will explore potential strategies and policy recommendations to mitigate digital inequality in rural healthcare. These strategies, grounded in an understanding of historical challenges, aim to chart a path forward for enhancing healthcare equity in digitally underserved rural communities.

Bridging the gap: Strategies for digital inclusion in rural healthcare

A historical analysis of healthcare delivery outcomes in rural Africa provides a baseline for understanding the potential impact of e-health systems (Hege et al. 2007). Tracing historical patterns of healthcare accessibility in rural areas informs strategies for leveraging e-health to overcome geographical barriers. Understanding how communities have historically accessed healthcare services guides the development of innovative telemedicine and mobile health solutions. To explore the potential of e-health systems, a case study of the adoption and implementation of e-health systems in primary healthcare in rural areas was conducted using district clinics and hospitals at Chris Hani District Municipality in the Eastern Cape province of South Africa. The population of this study included all healthcare professionals employed through four hospitals and six clinics. Data were collected from 73 healthcare professionals using a cluster quantitative sampling method. The study found that many healthcare professionals reported that they still keep patient records manually, although they believe digital record keeping would improve the handling of patient records. The significant challenges faced included outdated or faulty ICT infrastructures, poor power supply and Internet accessibility, availability and access to electronic health records management systems EHRMSs and lack of awareness of it, lack of skilled or trained personnel, heavy workload either from attending to patients or attending to administration duties and lack of computer literacy among the healthcare professionals. The challenges identified from the aforementioned case study align with several challenges identified in the literature (Waters et al. 2010). Hence, this underscores the need for targeted strategies to bridge the digital divide in rural primary healthcare.

To demonstrate successful implementations of digital inclusion in rural healthcare in sub-Saharan Africa, it is essential to consider the challenges and opportunities associated with this endeavour. It is crucial to note that digital financial inclusion has the potential to bridge the urban-rural divide and empower rural development (Demir et al. 2020). This is particularly significant in the African continent, where digital financial services can address issues of access for populations in rural areas (Gabor & Brooks 2016). In the healthcare context, the successful implementation of digital inclusion initiatives in rural areas can significantly impact the delivery of primary healthcare services. Challenges exist, such as uncertain changes reaching rural areas and the need to explore the extent of primary healthcare implementation in remote settings (Visagie & Schneider 2014).

Adopting quality assurance models has been shown to add value and ensure the success of information technology projects in rural health settings (Ruxwana, Herselman & Pottas 2014). Furthermore, implementing telemedicine applications and remote healthcare facilities has been identified as a potential strategy for successful rural healthcare delivery in sub-Saharan Africa (Faruk et al. 2020). Their study offers ways of attaining successful implementation of telemedicine applications and remote healthcare facilities in Africa, which is crucial for digital inclusion in rural healthcare (Faruk et al. 2020). Additionally, the authors provide an operational assessment of point-of-care diagnostics in rural primary healthcare clinics in KwaZulu-Natal province, South Africa, highlighting the challenges and opportunities for digital inclusion in rural healthcare settings (Mashamba-Thompson, Sartorius & Drain 2018).

While implementing digital inclusion initiatives in rural healthcare settings presents challenges, it also offers empowerment and social inclusion opportunities. By leveraging mobile platforms and digital technologies, rural areas can transition from the digital divide to social inclusion. This would, in turn, enhance access to essential healthcare services (Huang & Zhang 2022). The successful implementation of digital inclusion in rural healthcare in the sub-Saharan African continent requires a comprehensive understanding of the challenges, opportunities and potential impact of digital financial inclusion and telemedicine initiatives. This section further explores approaches to digital inclusion, considering the unique socio-economic and infrastructural context of rural African communities.

Community engagement and empowerment

Strategies for promoting digital literacy through community-based programmes are briefly discussed. The section emphasises the importance of incorporating local knowledge and cultural context into digital health interventions.

Promoting digital literacy through community-based programmes

Digital literacy forms the cornerstone of successful digital inclusion. More efforts should be channelled towards emphasising the importance of community-based programmes to enhance rural populations' digital literacy. Tailored workshops, training sessions and awareness campaigns are explored as effective tools for empowering individuals to navigate and leverage digital health technologies (Birkhead, Klompas & Shah 2015). The discussion delves into the need for culturally sensitive educational materials and emphasises community involvement in designing and implementing these programmes.

Incorporating local knowledge and cultural context

Recognising the diversity of cultures within rural African communities, the chapter advocates for the incorporation of local knowledge and cultural context in the design of digital health interventions. Understanding community-specific beliefs, practices and languages is essential for developing solutions that resonate with the population (Sands & Wald 2014). Case studies illustrating the successful incorporation of cultural elements into digital health programmes are examined, demonstrating the positive impact of culturally competent approaches on user acceptance and engagement.

Public-private partnerships

The role of collaborations between government agencies, private sector entities and non-profit organisations is examined. Sustainable business models for private sector involvement in rural healthcare are proposed. Public-private partnerships (PPPs) are a strategic mechanism to pool resources and expertise for digital inclusion initiatives. Case studies presented below highlight innovative PPP models that have effectively addressed infrastructural challenges, improved connectivity and enhanced rural areas' overall digital health ecosystem.

In Kenya, Safaricom initiated an M-PESA project. M-PESA, which uses mobile money service, partnered with PharmAccess Foundation to create M-TIBA, a mobile health wallet. This platform allows users to save, send and spend funds specifically for healthcare. This project has attracted over 4 million users, increased access to healthcare services, especially in rural areas and provided financial protection against health emergencies (M-TIBA PharmAccess 2019).

Novartis, in collaboration with the Tanzanian Ministry of Health and Vodacom, launched SMS for Life to combat malaria. The system uses SMS technology to track and manage anti-malarial drug stocks. The collaboration helps to provide extensive training to healthcare workers. The simple SMS technology introduced is very suitable for low-resource environments such as rural areas of sub-Saharan Africa. The initiative has significantly reduced stock-outs of malaria drugs and enhanced logistics and supply chain management (Sue et al. 2016).

The Chipatala cha pa Foni (CCPF), or Health Centre by Phone, was a telehealth initiative by VillageReach in partnership with the Malawi Ministry of Health to improve maternal and child health through mobile phone consultations. However, because of challenges such as infrastructure issues (poor mobile network coverage in remote areas), sustainability (difficulty in securing long-term funding and local buy-in) and cultural barriers, the project has only achieved limited reach and low impact in most remote areas. Also, because of these challenges, the project eventually required significant modifications to continue (Van-Niekerk 2022).

Sustainable business models are crucial for the longevity and scalability of digital health initiatives. The discussion explores how the private sector can contribute to rural healthcare while ensuring financial viability. This section provides successful business models that align profit incentives with positive health outcomes, from mobile network operators investing in telecommunication infrastructure to technology companies developing cost-effective healthcare solutions. By addressing these factors, policymakers and stakeholders can develop effective strategies to bridge the urban-rural divide and improve healthcare delivery in remote settings.

In the ‘Future directions’ section, we explore emerging technologies and their potential to reshape rural healthcare in Africa. Understanding the historical context of technology adoption sets the stage for anticipating the impact of innovations on mitigating digital inequality.

■ Future directions

This section offers a forward-looking analysis of the potential impact of emerging technologies, such as artificial intelligence (AI) and telemedicine, in alleviating digital inequality. It outlines a research agenda for evaluating the effectiveness of these technologies in diverse African contexts, considering ethical implications, scalability and adaptability.

A comprehensive understanding of emerging technologies in rural healthcare requires a historical lens. Analysing past instances of technology adoption, from the introduction of EHRs to the integration of mobile health applications, provides insights into the factors influencing successful implementation. Historical technology adoption patterns elucidate challenges, successes and the contextual nuances that shaped the integration of new technologies. These insights inform a realistic assessment of the potential of emerging technologies in rural healthcare, allowing for the development of strategies that build on historical lessons (WHO 2019).

Artificial intelligence in diagnostics

The integration of AI in healthcare diagnostics holds promise for improving access to advanced diagnostic capabilities. Examining historical precedents of adopting new diagnostic technologies offers insights into challenges and opportunities. Understanding historical responses to introducing innovative diagnostic tools guides the development of strategies for effective AI integration.

Analysing historical data on the adoption of AI in healthcare settings helps anticipate challenges related to infrastructure, training and ethical considerations. Historical perspectives contribute to formulating policies and guidelines that ensure AI's responsible and equitable deployment in rural healthcare.

Long-term sustainability

This section discusses the importance of long-term planning and investment in ensuring the sustainability of interventions aimed at reducing digital inequality in rural healthcare. Beyond immediate gains, it explores the dynamics of sustained impact, considering factors such as adaptability to evolving technologies, policy formulation and community resilience.

Sustainability is a key consideration for ensuring the lasting impact of interventions. A historical analysis of healthcare initiatives provides a foundation for understanding the factors contributing to or hindering long-term sustainability. Examining past projects that achieved sustained impact offers lessons for designing interventions with enduring benefits. Understanding the historical drivers of sustainability, including community engagement, policy support and resource allocation, informs the development of strategies for ensuring the longevity of digital healthcare initiatives (Adedeji et al. 2018). Historical perspectives guide the identification of critical elements that contribute to the resilience of healthcare interventions in rural settings.

Policy frameworks have played a crucial role in shaping the sustainability of healthcare initiatives. Analysing the evolution of policies related to healthcare infrastructure, technology adoption and rural healthcare development provides insights into the factors that influence long-term sustainability. Understanding historical policy successes and challenges informs the development of future policy frameworks. Historical perspectives guide the creation of policies that address the dynamic nature of healthcare and technology, ensuring that interventions remain relevant and sustainable over time.

Conclusion

In conclusion, this chapter has provided a detailed exploration of 'Addressing digital inequality in rural primary healthcare systems in sub-Saharan Africa' by delving into the historical context of healthcare in Africa, understanding digital inequality, examining its causes and consequences, and proposing strategies for mitigation. This chapter aims to contribute to the scholarly discourse on improving healthcare access in rural Africa.

Through a detailed analysis of socio-economic, infrastructural and cultural dimensions, this chapter emphasises the importance of contextualising interventions within the historical trajectory of healthcare development. The comprehensive exploration of past successes and challenges in healthcare policies, community engagement and public-private collaborations provides a foundation for designing evidence-based strategies that address the root causes of digital inequality. By adopting a historical perspective, this chapter seeks to inform policymakers, healthcare practitioners, researchers and stakeholders involved in rural healthcare in Africa, encouraging a holistic approach that is not only technologically advanced but also deeply rooted in the continent's historical context.

The authors recommend that the sub-Saharan African governments should:

- Amend or come up with national health policies for the digitisation of healthcare systems in the continent, considering the historical and cultural fabric of the population.
- Devise strategies to procure, disseminate and maintain digital infrastructure in rural healthcare facilities to ensure equitable access for everyone.
- Embark on widespread awareness campaigns on electronic health implementation initiatives, especially among rural healthcare service providers.

- Train and retrain healthcare professionals to ensure effective utilisation of e-health initiatives to mitigate digital inequality among rural African healthcare systems.

Looking to the future, this chapter has outlined vital areas for research and intervention, including the integration of emerging technologies, such as AI in diagnostics, and the emphasis on long-term effectiveness and sustainability.

The next chapter will further explore the impact of digital inequality on service delivery in higher education, building on the discussions from Chapters 2, 3, 4 and 5.

Chapter 8

Impact of digital inequality on service delivery in African higher education

Courage Matobobo
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Godwin P Dzvapatsva
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Ricky M Ngandu
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Nomputumo L Ngesimani
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Hlanganani S Sibanda
Department of Management,
Faculty of Management and Public Administration Sciences,
Walter Sisulu University,
Butterworth, South Africa

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Abstract

Integrating digital technology in education promises to revolutionise learning and teaching, particularly in Africa's diverse and divided educational landscape. By leveraging digital platforms, students can access learning materials without the need of physical textbooks, aiming to level the educational playing field. Despite these advances, digital inequality remains a significant hurdle, with disparities in Internet access, infrastructure and digital literacy exacerbating educational inequalities across the continent. This chapter delves into the effects of digital inequality in African higher education institutions. A systematic literature review of documents retrieved from the Scopus and IEEE Xplore databases was conducted to understand the issue in depth and identify unique regional challenges. Findings indicate that the shortages of digital devices and infrastructure are significant barriers to educational achievement. Additionally, digital inequality limits opportunities for parents to support their children because of low digital literacy. This chapter highlights the complexities of digital inequality and its implications for educational service delivery, emphasising the urgency of addressing these disparities to ensure equitable access to education in the digital age.

Introduction

The impact of technology on society is significant and far-reaching in the continually expanding world of the digital age. In Chapter 7, we explored the pressing issue of digital inequality in rural primary healthcare systems across a diverse landscape of the sub-Saharan African continent. The insights drawn from Chapter 7 provide a crucial foundation for understanding the broader implications of digital inequality, particularly as we shift our focus to higher education.

Digital technologies have transformed how people access essential services in several sectors, such as education, health care, government and banking (Evangelista, Guerrieri & Meliciani 2014; Sardana & Singhania 2018; Todoruț & Tselentis 2018). This digital transformation, however, has not been consistent, resulting in digital inequality, which is a serious and ongoing challenge. The inconsistency in digital transformation results from geo-cultural disparities in infrastructure and technology attitudes, alongside demographic factors, such as age, education, socio-economic status and urban-rural divides. These factors contribute to enduring digital inequality, posing a persistent challenge globally. This gap in access to digital tools and resources has far-reaching implications, particularly in the delivery of services (Bélanger & Carter 2006; Huggins & Izushi 2002). This gap could mean that some people with little or no access to digital tools and resources are left behind in developing a country. Digital inequality, sometimes known as the digital gap, is more than a matter of technological haves and have-nots. It includes differences in access to digital devices, Internet connectivity, digital literacy and the capacity to traverse online platforms properly. These differences, based on socio-economic position, region, age and education, significantly impact how people interact with and profit from digital services (Baro, Obaro & Aduba 2019; Beaunoyer, Dupéré & Guitton 2020). Digital inequality hinders the equitable distribution and accessibility of services in the educational sector (Selwyn 2004; Van de Werfhorst, Kessenich & Geven 2022). A good example was noted during the coronavirus disease 2019 (COVID-19) pandemic, where many educational institutions in the remote parts of South Africa did not have the infrastructure necessary to continue with remote learning.

This chapter investigates the multidimensional influence of digital inequality on service delivery in the higher education sector, shedding light on the issues, implications and potential solutions. It investigates how digital gaps impede equitable access to educational services while exacerbating societal inequities. The following research questions guide this chapter:

What is the impact of digital inequality on higher education in Africa?

The remainder of the chapter is organised as follows: it begins with a review of the literature, followed by a presentation of the methodology employed. Next, the findings are discussed, which is then followed by an analysis of those findings and the chapter concludes with a summary.

Literature review

This section discusses the background literature on the impact of digital inequality on service delivery, focusing on education in Africa. Firstly, we provide an overview of digital inequality. We then particularise the digital inequality in the education sector.

Digital inequality

The majority of people tend to use the terms digital divide and digital inequality interchangeably. The two are not the same, but they are nuanced and can be explained as having the same impact on the country's digital capital. We will start by defining the digital divide, which is the worst-case scenario, but we will not suggest that inequality is better. Target 9.c of the sustainable development goals (SDGs) relates to access to information and communication technology (ICT). This agenda speaks directly to the digital divide. There is a dimension beyond the digital divide referred to as digital inequality (Heeks 2022). Digital inequality relates to the inequality held inside the 'online population', which has access to and uses the Internet and ICTs (Dimaggio & Hargittai 2001). To address the causes of the digital gap, Van Deursen and Van Dijk (2019) divide them into four main categories: motivational access, skill access, material access and usage access. Aspects influencing people's motivation to use computers are referred to as motivational access factors (Myovella, Karacuka & Haucap 2021). Sarkar et al. (2015) examined Africa's digital divide using five dependent variables: Internet, broadband, fixed telephone, mobile phone and virtual social networks. We present the digital divide as a subset of digital inequality, and this debate clarifies the digital inequality, which we will discuss in this section.

Digital inequality is the gap expressed through how the haves gain access and use technological expertise to exploit the full potential of ICTs. The impact of digital inequality can be measured by the level at which citizens can translate digital experiences into tangible offline opportunities (Ragnedda & Gladkova 2020). The digital access divide in South African higher educational institutions is associated with educational and income levels, exacerbating student inequality (Faloye & Ajayi 2022).

Digital service delivery in the education sector

Service delivery refers to the process of providing services to meet the needs and expectations of individuals, organisations or communities. Service delivery aims to provide services as effectively and efficiently as possible to the customer's satisfaction (Okpa 2019). Service delivery is critical in all sectors, such as education, government, health and business. Failure to deliver quality goods or services to customers has a negative impact on the organisation. This chapter focuses on service delivery in education. Quality service delivery is critical because it helps learners access and utilise resources, improving their knowledge and skill status (Nyirenda 2007). Digital technologies play a critical role in quality service delivery.

Importance of digital technologies in improving service delivery in education

Digital technologies can be used to provide equitable access to learning. Digital technologies can help students from remote or underserved places gain access to quality education by bridging geographical and physical constraints. Students can use digital technologies to access various learning resources, such as e-books, online libraries, educational websites and multimedia content. With the advent of remote learning and online classes, students can now take courses and engage in educational programmes without being physically present. Individual students who are geographically remote from educational institutions or who have mobility issues benefit from this. The challenge is that some students have limited or no access to these digital technologies that could provide equitable learning, narrowing the gap between those with access and those without. This could mean that those with access to digital technologies flourish in their learning, while those with limited access or no access are left behind.

Digital technologies bring flexibility and convenience to learning, as students learn at their own pace. Flexible learning is possible with digital technologies, which is especially beneficial for adult learners, working professionals and students with special schedule requirements. Online courses and materials should be easily accessible to the students so that they can access them anytime. This enables them to engage with the content whenever they can do their schoolwork. Digital technologies enhance the learning experience of students. Digital tools and platforms deliver students interactive, engaging and personalised learning experiences. Further, online education makes education accessible to individuals with physical disabilities or those who cannot attend traditional in-person classes because of various reasons. In addition, digital technologies enable remote learning and crisis resilience. During the COVID-19 pandemic, the need for service delivery for uninterrupted education was stressed (Alex 2022; Babbar & Gupta 2022).

Indicators of digital inequality on service delivery

Increasingly, services are being delivered digitally, making digital inequality an important factor for service delivery today. Concerns about ICTs-related inequalities have risen in governmental and academic circles ever since it became evident that the Internet will play a substantial role in all facets of life (Asmar, Mariën & Van Audenhove 2022). For instance, in South Africa, 70% of the population owns a smartphone, but affordability and digital literacy barriers restrict meaningful Internet use for the remaining 30%, excluding them from online tax filing or educational resources (Statistics South Africa 2023). Krönke's (2020) study conducted in Africa found that approximately one-third of all respondents (31%) in only seven countries use their cell phones and the Internet at least several times per week. This level of basic digital literacy is common (at least 50% of people) in Mauritius, Gabon, Tunisia, Sudan, South Africa and Morocco, but it is uncommon (10% or less) in Mali, Niger and Madagascar.

The non-availability of the Internet strengthens existing social inequalities, so poorer and most marginalised groups are at risk of being excluded (Helsper & Reisdorf 2013; Heponiemi et al. 2023). For equitable access to essential educational services and to reduce digital inequality, it is imperative to understand and address digital indicators.

Among the most common indicators of digital inequality is digital access. Sadly, people living in low-income areas are the most affected by access (Hernandez & Roberts 2018; Lechman & Popowska 2022). The reason for this is twofold: Firstly, remote communities are generally difficult to reach because of poor access. Governments claim that these areas are either inaccessible or lagging in development. Secondly, most people in remote areas have limited access to devices, or they have devices but lack the aptitude to use them. Geographical disparities are real, as rural areas have less infrastructure than their urban counterparts. Historically, colonial powers were more interested in developing areas where they lived, which has perennially continued to affect the current governments. In some instances, you find people who have laptops and computers, but they do not have a power supply.

Digital inequalities scholars (Haddon 2000; Selwyn 2004; Witte & Mannon 2010; Zillien & Hargittai 2009) point out that unequal Internet access and use will likely repeat pre-existing social divisions based on race, gender or even class. Digital equity may address digital exclusion and equality (Bailey & Nyabola 2021; Gottschalk & Weise 2023). In addition, a significant influence could be achieved through policy and advocacy by reducing taxes that digital service companies pay in response to providing services in remote areas and as a form of social responsibility.

The ability to benefit from technological advancements may be significantly impacted by individual differences in skill levels, income levels, quality of institutions, infrastructure and geographical locations (Myovella et al. 2021). The inequality in Internet use impacts service delivery for various organisations (Dewan & Riggins 2005). There is a stark difference in connectivity when a country experiences infrastructure bottlenecks, such as limited access to electricity, low ICT adoption (Myovella et al. 2021) and vandalisation of equipment. Thus, it is pertinent that digital service providers (DSPs) understand digital access challenges in these areas if the problem is to be reduced.

Besides access, language and cultural factors are indicative of digital inequality. Primarily, most digital services are not easily accessible in multiple languages, inhibiting those who are very proud of their heritage and cultural practices. Certain populations may be excluded unless digital services are available in multiple languages or are culturally sensitive.

In addition, we also note that digital literacy contributes immensely to digital inequality. Most of the services are now available on digital platforms, which is already a utopia for those who dream of having the simplest digital gadgets. Using some evidence witnessed during the COVID-19 pandemic, governments were glad that the education calendar was not affected heavily, but the long-term impact was that the students who benefitted most were those who were used to such platforms already. The result is that people are left behind, and inequality exists. Digital service providers, churches, educational institutions and governments should incorporate digital literacy sessions in their curriculum planning. Once digital literacy becomes a community-wide responsibility, everyone feels compelled to participate and move the mantra forward.

Furthermore, as mentioned earlier, economic disparities play a huge role in digital inequality. Socio-economic factors influence digital inequality. Those with lower incomes will likely have difficulty affording the necessary technology and Internet services. It also follows that DSPs would not want to invest in such areas because, economically, it does not make much sense when running a business. According to Ragnedda and Ruiu (2017), digital capital includes all of the experience, knowledge, literacies and skills required to acquire other forms of capital, such as economic, cultural, political, social and personal capital. It is common to consider infrastructure, geographic locations and socio-demographics as the main reasons behind the spread of digital inequality (Park 2017; Taipale 2013). Inequalities in access, use and expertise must be addressed to acquire digital capital (Ventrella & Cotnam-Kappel 2023), which is necessary to reap the visible benefits of the digital sphere. These indicators must be understood and addressed to create policies and programmes to eliminate digital inequality and guarantee equitable access to critical services for all. While our focal point is on the impact of digital inequality in education, the discussed indicators are generic across sectors, and education is not excluded.

■ Multifaceted challenges of digital inequality in African education

The digital transformation inconsistencies in African education are characterised by geographic, gender-based, linguistic, socio-economic and generational factors (Kanyane 2023). Poor countries and rural areas consistently lag behind developed and urban centres in digital infrastructure and connectivity, significantly impacting educational service delivery (Joseph 2019). In sub-Saharan Africa, 82% of learners do not have access to the Internet in their homes, and 89% do not have home computers (Namale 2021). This disparity is further compounded by gender inequalities, with girls often having less access to digital resources because of societal norms and expectations. The gender gap in Internet use between 2013 and 2019 in Africa widened by 25% (Gillwald & Partridge 2022). Language barriers present another significant challenge, as the predominance of English-language digital content can hinder learning in non-Anglophone African countries. The exclusivity of the English language in all Internet media overshadows African and other global languages; this is clearly evident where English dominates at 45% and is followed by other European languages like German (5.90%), French (4.41%) and Spanish (3.80%) (Yaman 2015). While mobile learning initiatives have shown promise in bridging these gaps, they face limitations such as device affordability and data costs. In South Africa, the #DataMustFall campaign highlighted how high data costs impede educational access (Gillwald, Mothobi & Rademan 2018). The effectiveness of digital education is further hampered by inadequate teacher preparedness in integrating digital tools into their pedagogy. Some of the major barriers to preparedness include a lack of computer hardware, software, reliable Internet connections, technical support and teachers' expertise in using ICT (Hennessy, Harrison Edexcel & Wamakote 2010; Sayed et al. 2021). Socio-economic factors contribute to these challenges, where household income levels strongly correlate with access to digital devices and Internet connectivity. In South Africa, students from the wealthiest quintile are more likely to have Internet access at home compared to those from the poorest quintile (Statistics South Africa 2022). Importantly, parental digital literacy also plays a crucial role in students' educational outcomes and access to educational services. A study conducted in Kenya and Côte d'Ivoire to explore mobile learning adoption during schooling disruptions presented findings that show the willingness of parents to support their children in schooling but were hampered by barriers that include a lack of time because of work commitments, affordability, literacy and digital literacy (Kizilcec et al. 2021). This generational digital divide often leaves parents unable to actively participate in their children's education, which is increasingly being transformed through digital interventions, potentially widening the achievement gap between students from digitally literate and illiterate households.

Methodology

A systematic literature review, using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al. 2009), of studies evaluating digital inequality's impact on higher education in Africa, has been performed.

The following search string was used in the Scopus Database: 'digital inequality' OR 'digital divide' in 'higher education' OR tertiary OR university in Africa. The authors used the Scopus database because it is one of the largest recognised databases which covers the topic under study. Scopus has an extensive and varied library of peer-reviewed publications. This wide reach makes it more likely that you will uncover high-quality, pertinent research from various fields, such as communication, technology, social sciences and education.

Figure 8.1 shows the screening process of the articles that were analysed. The initial search retrieved 96 articles. The authors conducted an initial analysis, and 54 articles met the inclusion criteria, while 42 articles met the exclusion criteria. Informed by Kitchenham (2007) and Harpur (2018), the following inclusion and exclusion criteria were used.

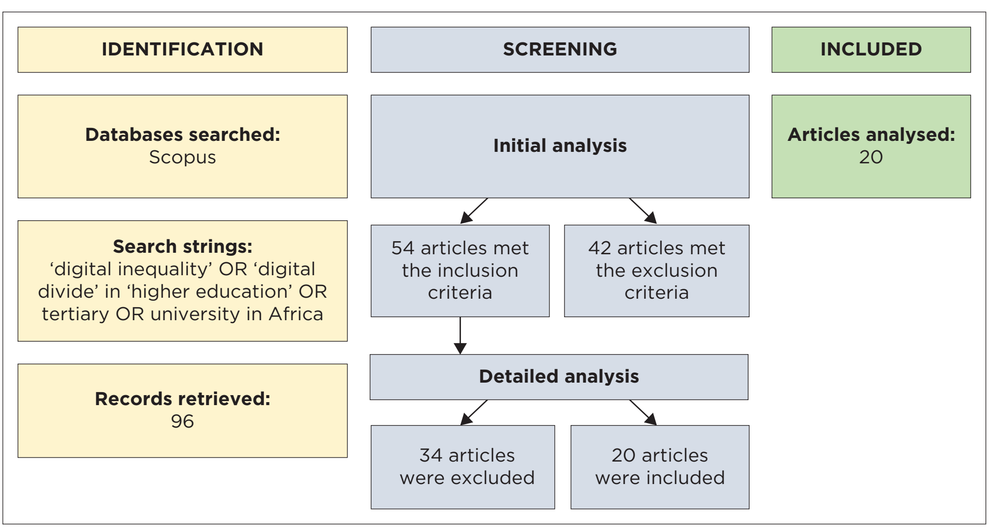
The inclusion criteria were determined using the following search items:

- Addresses the impact of digital inequality on service delivery
- Pertains to the education sector
- Having an abstract available
- Written in English
- Articles focus on Africa.

The following exclusion criteria were applied:

- Does not address the impact of digital inequality on service delivery
- Does not focus on the education sector
- Does not have an abstract
- Not written in English.

These 42 articles were excluded for the following reasons: not focusing on digital inequality, not focusing on higher education, not written in English and not having an abstract. In this analysis, only 20 articles were reviewed, and 34 articles were excluded because of their relevance to the research question. A detailed analysis of 54 articles was conducted, and 34 articles were excluded as they were not addressing the research question.



Source: Authors' own work.

FIGURE 8.1: Screening process of articles.

Only 20 articles were relevant to the research question and were considered in the final analysis. Figure 8.1 illustrates the PRISMA guidelines that guided the systematic literature review on the impact of digital inequality on service delivery in African education.

Results

We conducted a systematic literature review, and our key findings on the impact of digital inequality on education are presented as follows:

- Limited devices and Internet access
- Geographic and socio-economic disparities
- Digital literacy and skill deficiency
- Impact on educational outcomes
- Institutional challenges.

Limited devices and Internet access

Digital inequality is prevalent because of limited access to devices and stable Internet connections. For instance, Kumi–Yeboah, Kim and Armah (2023) highlight that students, particularly in rural areas of Ghana, face significant barriers during COVID-19 because of insufficient devices and unreliable Internet. This leads to challenges in enrolling in distance learning courses. Similarly, in Nigeria, Heyward-Rotimi (2023) finds that poor Internet connectivity hinders lecturers, professors and students from accessing up-to-date digital articles, thereby limiting their engagement in contemporary academic debates. In South Africa and Zimbabwe, Chibuwe and Munoriyarwa (2023) note that both students and lecturers struggle with device and Internet data shortages, leading to difficulties in attending online classes and an increased workload for lecturers.

Geographic and socio-economic disparities

Geographic and socio-economic factors further exacerbate digital inequality. In South Africa, Mokoena and Van Vuuren (2023) observe that students face device incompatibility and functionality issues, which were compounded by the COVID-19 pandemic, leading to a disrupted educational experience. Majola and Mudau (2022) report that the high cost of data bundles, weak network signals and poor network coverage in South Africa prevented students from accessing university technology centres during the pandemic, negatively impacting their academic performance. Additionally, Woldegiorgis (2022) highlights that South African higher education institutions and students face barriers to expanding higher education access beyond campus spaces because of a lack of ICT infrastructure and high data costs.

Digital literacy and skill deficiency

A lack of digital literacy and technical skills also contributes to digital inequality, consequently reducing learning opportunities. Vurayai (2022) identifies that in sub-Saharan Africa, lecturers and students struggled with transitioning from traditional face-to-face to online learning because of limited technical knowledge and insufficient power supply. Mudau et al. (2022) note that South African students face difficulties accessing learning management systems because of limited data and unstable Internet connections. Our findings point out the impact of digital literacy. Furthermore, Faloye and Ajayi (2022) report that digital illiteracy and lack of support significantly impacted African students' ability to complete computer-based learning assignments. There is a general thinking that parents lacking digital literacy find it difficult to actively participate in their children's education, reducing the crucial home-school connection. While in most rural areas and communities of low economy, parents are hardly involved as they are doing the task of making sure that there is food on the table, our literature did not highlight parental involvement and digital inequality's effect on education.

Impact on educational outcomes

The digital divide has profound impacts on educational outcomes. For example, Mphahlele et al. (2021) find that students in Botswana, South Africa and Zambia face challenges in submitting tasks and accessing online resources, leading to poor academic performance. Mpungose and Khoza (2021) observe that in South Africa, students' socio-economic background influences their access to technology resources, resulting in a social divide that makes e-learning ineffective. Matsilele (2021) reports that online learning adoption during the COVID-19 pandemic was hindered by connectivity issues and limited access to devices, leading to repeated lessons and ineffective online resources.

Another challenge from the literature and our findings is that digital inequality increases the workload for educators as they try to balance access to learning material (Chibuwe & Munoriyarwa 2023). In addition to a heavier workload, expenses go up. While our data did not support this, there is a possibility of varying material quality as instructors attempt to provide education on various platforms. This has a direct impact on the learning results.

Institutional challenges

Institutions also face challenges because of digital inequality. Williams, Dhoest and Saunderson (2019) highlight that academic librarians and students in South Africa were impacted by poor Internet connectivity and a lack of computers, which hindered professional progress and work performance. Similarly, Basitere and Ivala (2017) report that chemical engineering students faced an unbalanced learning environment during protests because of limited computer access and wireless fidelity (Wi-Fi). Lastly, Parve et al. (2016) indicate that health sciences students in Zimbabwe faced compromised educational quality because of limited access to digital medical resources.

The discussed themes underscore the multifaceted nature of digital inequality, affecting various aspects of educational access and quality across different regions and demographics.

Discussion

This chapter aims to answer the question: How does digital inequality affect African higher education? Research on digital inequality and the impact of exclusion on education in different parts of Africa was conducted through a systematic literature review.

The primary causes of digital inequality identified include limited access to devices and Internet connectivity, geographic and socio-economic disparities, institutional challenges, and deficiencies in digital literacy and skills. These factors are particularly pronounced in Africa, where state-owned companies often monopolise digital service provision. These monopolies are notorious for their inefficiencies, which further exacerbate the problem.

The chapter also reveals that resources earmarked for digital transformation in education are sometimes redirected to other sectors that political parties believe will help increase voter support. This diversion of funds impedes the progress needed to achieve digital equity in education. Additionally, the most remote areas in Africa, which already suffer from a lack of basic education infrastructure, are disproportionately affected by digital inequality. Policymakers often prioritise fundamental educational resources such as books, classrooms and teacher accommodation over digital infrastructure. This prioritisation makes sense in contexts where basic educational needs are not yet met, but it also delays the advancement towards digital equity. Other findings ride on limited infrastructure and access; once this is dealt with, we believe the rest will become easier to address and manage.

Another challenge from the literature and our results is that digital inequality increases the workload for educators as they try to balance access to learning material (Chibuwe & Munoriyarwa 2023). In addition to a heavier workload, expenses go up. While our data did not support this, there is a possibility of varying material quality as instructors attempt to provide education on various platforms. This has a direct impact on the learning results.

The literature reviewed supports our findings, consistently pointing out that limited access to devices and Internet connectivity exacerbates digital inequality in the education sector (Myovella et al. 2021). While there has been an increase in the number of stakeholders providing digital devices and Internet access to educational institutions in various parts of Africa, the available resources are insufficient to achieve digital equity comparable to that of developed countries. We strongly believe that access to infrastructure is the greatest challenge, which results in digital inequality within the education sector.

Looking at the impact, the most significant hardship occurred during COVID-19 when students struggled to learn because of the shift to online classes (Alex 2022; Babbar & Gupta 2022). As most educational institutions now rely on learning management systems, the lack of digital devices and Internet access meant that many students could not access course content, submit assignments or utilise the same research resources as their peers (Bradley 2020). This digital divide negatively affected their learning experiences. While this chapter did not specifically examine dropout rates, it is widely recognised that school dropout rates are significantly higher in rural areas, likely exacerbated by these digital inequalities. Unfortunately, when national examinations are prepared, there is often a disregard for these persistent inequalities, with examiners setting assessments to national standards for ranking educational performance without considering the disparities in digital access.

Several key recommendations emerge from this chapter to reduce the impact of digital inequality in education. Firstly, accelerating the provision of digital infrastructure in underserved communities should be spearheaded from a policy perspective by deploying any digital services to start in these areas moving into towns. We are cognisant that even in towns, there are still pockets of digital inequality within educational sectors. This approach ensures that the most underserved regions benefit from advancements first. This chapter emphasises the importance of conducting a thorough resource analysis for educational initiatives. This analysis should ensure that all students have equitable access to necessary resources. Additionally, curriculum design, assessment setting and the deployment of qualified personnel should follow this comprehensive resource analysis to ensure an effective and inclusive educational environment. We would also like to put it up to the people to learn and develop the areas where they came from. It should not be left to the government or non-governmental organisations alone. While the United Nations is at the forefront of advocating for quality education in its SDGs, we feel that they can do more by assisting the struggling countries that are members of the organisation by looking for donations on their behalf. Further, proper monitoring of the disbursed funds can help mitigate the misuse and diversion of funds meant to address digital inequality. This chapter provides incremental literature on the impact of digital inequality.

The results on digital inequality in African education, particularly in South Africa, indicate broader systemic issues stemming from historical inequalities. Because of high levels of illiteracy, the digital divide causes a vicious cycle that keeps people in poverty. As long as the digital divide does not narrow, the inequalities stemming from learning environments will perpetuate into economic, political and social inequalities.

We recommend a stronger partnership between the private and public sectors to drive digital equity in education. Implementing a National Digital Inclusion Strategy that caters to all individuals, irrespective of geographic location, has strong potential to mitigate the impact of digital inequality. An innovative recommendation would be to introduce a scheme where students from underserved communities can purchase devices at a lower cost from providers, accompanied by tax rebates. Of course, these recommendations require thorough monitoring to avoid abuse. We remain hopeful that African countries have the potential to address digital inequality in the education sector because of the growing awareness of its impact. One of the limitations of this chapter is the limited voices of students on both sides of the digital divide. Building relationships between universities and local firms, fostering entrepreneurship and innovation hubs, and focusing on skills development relevant to the local economy will help bridge this gap and enhance employability. We also advocate for incorporating digital literacy training into the curriculum, delivering workshops and tutorials, and fostering peer-to-peer learning to provide students with the necessary skills.

Conclusion

Future studies could compare opportunities and outcomes from a broader perspective. Nonetheless, we are convinced that this chapter has highlighted the impact of digital inequality to such an extent that, if the report reaches government officials, DSPs, and policymakers, they will have much to learn and a clear direction to follow moving forward.

As Chapter 8 concludes on the impact of digital inequality on service delivery in African higher education, it is essential to transition to the next critical discussion. Chapter 9 delves into mitigating the unintended consequences of digital inequality in South African society. This upcoming chapter will explore strategies and solutions to address the disparities highlighted in our current discussion, focusing on creating a more equitable digital landscape.

Chapter 9

Mitigating the unintended consequences of technology adoption in South African higher education

Olutoyin Olaitan
Department of Applied Informatics and Mathematical Sciences,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Isaac O Ajao
Department of Statistics,
Faculty of Science and Computer Studies,
Federal Polytechnic,
Ado-Ekiti, Nigeria

Abstract

This chapter investigates the profound effects of technology integration in South Africa's higher education sector. While the adoption of technology promises numerous advantages, such as enhanced access to educational materials and improved pedagogical practices, it also generates unintended repercussions. Key issues include digital disparities, unequal access to technological resources and varying levels of digital literacy among students and educators. The chapter critically examines the challenges during the swift transition to online learning, a shift intensified

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by the coronavirus disease 2019 pandemic, which highlighted and widened existing socio-economic gaps. It underscores the necessity for comprehensive strategies to tackle these challenges, advocating for investments in digital infrastructure, specialised digital literacy initiatives and collaborative efforts among educational institutions, governmental bodies and industry stakeholders. The complexities of rapidly implementing technology in a context already marked by digital inequality further complicate the pursuit of an equitable educational landscape. By addressing these unintended consequences, the chapter submits that a just and equitable higher educational environment can be fostered in South Africa.

Introduction

Chapter 8 investigated the impact of digital inequality on service delivery in African higher education. It highlighted how disparities in Internet access, infrastructure and digital literacy contribute to educational inequality across the continent. Major impediments such as limited access to digital devices and infrastructure shortages were identified as significant barriers to educational success. The chapter emphasised the need for equitable access to digital tools and resources to ensure quality education for all students. Chapter 9 further explores these insights by investigating technology adoption in the South African higher education landscape.

The adoption of technology in higher education has transformed teaching and learning paradigms globally, yet it brings a spectrum of unintended consequences, particularly in the South African context. The adoption of technology in South African higher education offers significant benefits. It improves access to educational resources, allowing students from remote areas to participate in online courses and access high-quality materials (Ng'ambi et al. 2016). Technology enhances teaching and learning through dynamic and personalised instructional methods, leading to better academic outcomes (Waghid, Waghid & Waghid 2016). Additionally, it equips students with essential digital literacy skills, preparing them for the digital economy (Enakrire & Ocholla 2017). Furthermore, technology fosters collaborative learning and knowledge sharing, creating a sense of community and encouraging innovation (Masenya 2021). These advantages highlight the importance of integrating technology into higher education to create a more inclusive and effective educational environment. As South African universities increasingly integrate digital tools and technologies into their curricula, it is essential to critically examine how these changes affect students, educators and the educational landscape as a whole. This chapter explores the unintended consequences that are a result of this technological shift.

In South Africa, the transition to online learning, accelerated by the coronavirus disease 2019 (COVID-19) pandemic, forced most institutions to quickly adapt to technology for teaching and other academic endeavours. This rapid shift highlighted several critical issues, including disparities in technology and Internet access, variations in digital literacy among students and educators, and the psychological impact of online learning environments (Mhlanga & Moloi 2020). Educators also faced challenges in adapting to modern technologies and developing effective pedagogical strategies for technology-driven learning. For many educators, the sudden transition resulted in a steep learning curve, as they were required to innovate and adapt their teaching methods without adequate training or resources (Mabidi 2024). This scenario often led to a reliance on traditional pedagogical approaches that may not align with the capabilities of digital platforms, thereby limiting the potential benefits of technology in enhancing student engagement and learning outcomes (Makua, Mhlanga & Moloi 2023).

Moreover, the unintended consequences of technology adoption extend beyond logistical challenges. The shift to online education has reshaped the student experience, often exacerbating existing inequalities within the South African education system (Aruleba, Jere & Matarirano 2022). Students from disadvantaged backgrounds often struggle with limited access to devices and stable Internet connections, hindering their ability to participate fully in online learning. This digital divide impacts academic performance and raises concerns about the long-term implications for social mobility and equity in education (Boughey & McKenna 2021). As universities navigate this complex landscape, developing strategies that mitigate these unintended consequences is crucial. This chapter aims to provide a nuanced understanding of the unintended consequences of technology adoption in South African higher education. By examining the interplay between technology adoption in higher education and the unique socio-economic context of South Africa, pathways to mitigate negative impacts and promote a more equitable and effective educational landscape can be proposed.

The main research question that the chapter aims to answer is thus stated: 'How can South African higher education institutions effectively mitigate the unintended consequences of technology adoption?' The first objective discusses the unintended consequences of technology adoption in higher education. We argue that the negative outcomes of technology adoption in the South African higher education landscape include the aggravation of digital inequalities, leading to several other challenges. The chapter contends that this is an important subject as these unintended consequences may challenge South Africa's ability to achieve the United Nations sustainable development goal 4 of inclusive and equitable quality education for all by 2030. Addressing digital inequality recognises that simply providing access to technology is not enough to solve the digital divide problem, as structural conditions and socio-economic factors play a significant role (Vincent, Idahosa & Msomi 2017). Scholars emphasise the need to move beyond access and skills and consider the complex ways in which the unintended consequences of digital inequalities arise in different contexts whereby technology is adopted to facilitate and enhance the higher education experience (Robinson 2012). Van Deursen and Helsper (2015) and Ferrante et al. (2024) provide multilayered definitions of digital inequalities, highlighting the systematic differences in the ability and opportunity to use information and communication technologies (ICTs) and the variations in digital and social contexts, skills and life outcomes associated with these differences. The second objective of the chapter is to propose solutions designed to mitigate the unintended consequences created by technology adoption in higher education. The chapter strives to highlight the intricacies of higher education's technology adoption and its unintended consequences and to provide a meaningful pathway for addressing these challenges and fostering a more equitable society.

■ Methodology

The chapter employs a comprehensive literature review methodology to explore the unintended consequences of technology adoption in South African higher education. The literature review is chosen because of the evolving nature of the topic and the need to incorporate a wide range of perspectives and findings from existing research (Booth et al. 2021). This approach allows for a thorough examination of the current state of knowledge, identification of gaps and synthesis of insights relevant to the South African context.

The literature review comprises several sources, including academic journal articles and books that discuss the impact of technology on higher education. The review is structured to cover several key areas, namely, the concept of unintended consequences, digital inequalities, the socio-economic context of South Africa and strategies for mitigating negative impacts.

The theoretical framework for this study is grounded in the concept of unintended consequences, as articulated by seminal authors such as Karl Marx and Robert K. Merton. Merton's (1936) work on unintended consequences provides a foundational understanding of how actions, particularly those related to policy and technology adoption, can lead to unforeseen outcomes. Merton's framework is critical for this study as it highlights the complexity of social systems and the inherent challenges in predicting all the possible outcomes of specific actions. Karl Marx's historical materialism also offers valuable insights into the unintended consequences of technological advancements. Marx and Engels (1973) discuss how technological progress, while intended to improve productivity and societal conditions, can also lead to new forms of inequality and social stratification. This perspective is particularly relevant in the South African context, where the rapid adoption of technology in higher education has the potential to both bridge and widen existing socio-economic divides.

The choice of a literature review is justified by the ongoing and evolving nature of technology adoption in South African higher education. Given the rapid pace of technological change and its profound impact on education, it is essential to continuously update and expand the body of knowledge on this topic. A literature review allows for the inclusion of the most recent research and contextual studies, providing a comprehensive understanding of the current landscape (Snyder 2019). Moreover, the literature review approach enables the integration of diverse perspectives, including those from seminal authors and contemporary researchers. This synthesis of historical and current viewpoints is crucial for understanding the unintended consequences of technology adoption and identifying effective strategies to address these challenges.

As a result of the research problem being investigated, the chapter places a strong emphasis on research situated in the South African context. The unique socio-economic conditions, historical inequalities and educational landscape of South Africa necessitate a tailored approach to understanding the impact of technology adoption in higher education. Contextual relevance of the reviewed literature is required for grounding the findings in the realities of South African higher education, ensuring that the proposed solutions are relevant and practical.

The articles for the study were collected from a variety of academic databases, including JSTOR, Google Scholar and other academic databases. Keywords such as 'technology adoption', 'higher education', 'unintended consequences', 'digital divide' and 'South Africa' were used to identify relevant studies. The selected literature was thereafter analysed to extract key themes, patterns and insights related to the unintended consequences of technology adoption.

The methodology provides a robust framework for exploring the unintended consequences of technology adoption in South African higher education. By integrating seminal theories with contemporary research and contextual insights, this approach offers a comprehensive understanding of the challenges and opportunities associated with technological advancements in education. This methodology highlights the complexities of the issue and paves the way for developing informed and effective strategies to mitigate negative impacts and promote equitable access to education.

The concept of unintended consequences

Unintended consequences refer to outcomes or effects that arise from actions that were neither intended nor anticipated (Merton 1936). This concept is applicable across various fields and highlights the unexpected results that can occur when individuals or institutions implement decisions or policies. Understanding unintended consequences is crucial for grasping the complexity of social systems and the inherent challenges in predicting all possible outcomes of specific actions (Walsh, Dong & Tumer 2019). Although the concept is not a formal theory, the consideration of unintended consequences within the framework of critical theory is vital for this study. It provides a valuable lens through which to explore the complexities and uncertainties associated with the widespread adoption of technology and its implications for higher education.

In higher education, technology serves as a double-edged sword, possessing the potential to bridge gaps and democratise access to knowledge while simultaneously deepening existing inequalities (Woldegiorgis 2022). Recognising unintended consequences is essential for understanding how technology and the digital divide can deepen social and economic polarisation, ultimately leading to social injustice. Elam (2022) argues that reliance on technology in education may inadvertently intensify existing biases. Similarly, algorithms and machine learning systems employed in educational technology often perpetuate and amplify societal prejudices (Elam 2022; Nguyen et al. 2021). For instance, if these systems are trained on biased datasets, they may unintentionally reinforce discriminatory practices that disadvantage specific groups of students based on race, socio-economic status or other factors. This increases existing social divisions and institutionalises discrimination within the educational system (Gardner 2022).

Moreover, the race to adopt digital solutions in higher education frequently overlooks the socio-economic factors that influence access to technology. Studies have shown that students from low-income households in South Africa often lack the necessary devices or reliable Internet connectivity, which hinders their ability to participate in remote learning or access online resources (Aruleba et al. 2022; Boughey & McKenna 2021). This digital exclusion not only widens the educational gap but also perpetuates a cycle of disadvantage, as these students struggle to develop the digital skills essential for success in the modern workforce (Boughey & McKenna 2021; Makua et al. 2023). Another unintended consequence of the emphasis on technology in education is the potential prioritisation of certain skills over others, which can lead to an uneven distribution of opportunities in the job market (Rodriguez, Garcia-Ruiz & Aguaded 2020). While digital literacy is undeniably crucial in the 21st century, an overemphasis on technological skills may overshadow the importance of other critical competencies, further marginalising individuals who may excel in non-technical fields. Makua et al. (2023) argue that this may result in social and economic polarisation and social injustice. Acknowledging these unintended consequences is a vital step towards formulating inclusive and equitable educational policies that address the multifaceted challenges of technology integration.

In the context of digital divide and digital transformation, unintended consequences can be further explored through historical perspectives, particularly as articulated by Engels and Marx (1973). Engel's retrospective philosophy suggests that unintended consequences are inherent in examining 'past history'. This perspective implies that as societies progress, they may not fully anticipate the outcomes of their actions, resulting in consequences that unfold in unforeseen ways. In digital technology, the digital divide – defined as the gap between those who have access to modern ICT and those who do not – can be seen as an unintended consequence of the rapid advancement of digital tools. This divide may arise from numerous factors, including economic disparities, unequal educational opportunities and infrastructural limitations.

Conversely, Marx and Engels (1973) connect unintended consequences with a prospective vision, positing that such outcomes are not solely a feature of historical analysis but can also be understood in future developments. In digital transformation, efforts to bridge the digital divide and enhance digital inclusivity may inadvertently give rise to new forms of inequality or challenges. For instance, as societies strive for greater connectivity and digitalisation, issues related to privacy, data security and ethical considerations may emerge, posing unintended consequences for individuals and communities.

The complexity of developmental and historical processes reveals how the decisions of governments, organisations and individuals intersect and conflict in their pursuit of various goals. In the digital realm, this complexity is reflected in stakeholders' diverse motivations and interests, including governments, corporations and individuals. Efforts to digitally transform and reduce the digital divide may encounter obstacles and conflicting objectives, resulting in outcomes that diverge from the initially intended goals.

In the pursuit of technology adoption in South African higher education, aligning with the developed world and a future that benefits all of society, planned and rational coordination is critical to achieving consciously intended outcomes. Achieving this aspirational goal within the context of digital transformation requires careful consideration of potential unintended consequences, proactive measures to address them and collaborative efforts to align individual wills towards a shared and consciously intended future in the digital landscape. This is particularly critical in higher education, where a deep chasm exists between privileged and underprivileged students (Mhlanga & Moloi 2020). Section titled 'Unintended consequences of technology adoption in higher education: The South African context' will explore the various forms of unintended consequences faced in South African higher education as a result of the adoption of technology.

Unintended consequences of technology adoption in higher education: The South African context

As South Africa rapidly embraces the digital age, there is emergent evidence that digital inequality has emerged, causing unintended negative outcomes that impact various parts of society (Mabidi 2024). The adoption of technology for teaching and learning, administration and other facets of the South African higher education landscape has also been impacted by these developments. The significance of digital inequality, marked by differences in access to, adoption of, and skilful use of digital technologies, has become more pronounced within the country's complex socio-economic landscape, which mirrors itself in the higher education institutions (Shibambu & Mojapelo 2024). This section explores these unintended consequences in South African higher education, highlighting the urgent need for a comprehensive strategy to address and mitigate these issues.

Foremost among these consequences is the aggravation of extant socio-economic disparities (Vincent et al. 2017). Aruleba et al. (2022) argue that the rapid transition to online education in South Africa at the onset of the COVID-19 pandemic has revealed significant unintended consequences, particularly highlighting the disparities created by the digital divide. The sudden shift to emergency remote learning exposed critical weaknesses in technology infrastructure across many universities, especially those historically disadvantaged (Boughey & McKenna 2021; Woldegiorgis 2022). Many institutions lacked the necessary resources to support effective online learning, resulting in a situation where students from disadvantaged backgrounds faced substantial barriers to educational success (Woldegiorgis 2022).

Research indicates that the problems encountered during this transition were multifaceted. Poor technology infrastructure was a prevalent issue, as many universities struggled to provide reliable Internet access and adequate technical support for lecturers and students (Boughey & McKenna 2021). This lack of infrastructure not only hindered the effective delivery of online education but also amplified existing inequalities as students under lockdown in rural areas struggled to access classes because of poor signals in their locations in spite of the fact that universities had made provision for data (Mabidi 2024). Many students also lacked access to essential devices crucial for participating in online learning environments, as lockdown conditions made delivery to rural areas difficult.

A study by Kamal, Mhlanga and Moloi (2020) also underscores that technical challenges, including software and hardware issues, were common obstacles encountered by students in South African institutions during this transition. These barriers not only affected students' ability to engage with course material but also diminished their overall educational experience, leading to lower academic performance and increased dropout rates (Aruleba et al. 2022).

Another primary unintended consequence of technology adoption in higher education is student disengagement because of unfamiliarity with technology (Ivala & Kioko 2013). Many students, particularly those from disadvantaged backgrounds, lack the necessary digital literacy skills to effectively engage with the technologies adopted for learning platforms and resources. This lack of familiarity often leads to feelings of frustration, confusion and disengagement, hindering their academic performance and success. Ivala and Kioko (2013) at the Cape Peninsula University of Technology (CPUT) found that student engagement is linked to academic success. Students with low levels of engagement are more susceptible to adverse consequences, such as disruptive behaviour, absenteeism and dropping out of their studies. In technology-driven learning, students unfamiliar with the required tools and platforms may disengage from their studies altogether, leading to long-term negative impacts on their educational and career prospects.

In agreement, a study by Batisai, Makhafola and Maoba (2022) noted that while higher education institutions are working hard to achieve quality in academic operations, student participation is minimal in South Africa. In technology-driven learning, students unfamiliar with the required tools and platforms may disengage from their studies altogether, leading to long-term negative impacts on their educational and career prospects. Faloye and Ajayi (2022) examined the impact of technology adoption on first-year students at the University of Kwazulu-Natal. The study reported a significant relationship between the timing of access to technology and computer anxiety with a student's computer self-efficacy. Furthermore, the study indicated that students from disadvantaged backgrounds face particular challenges related to hardware components and application programmes. These students frequently encounter outdated or malfunctioning computer hardware, which hampers their ability to effectively engage with digital learning tools. They also struggled to access and use essential software applications, further exacerbating their technological disadvantage.

While the integration of digital tools and platforms holds the promise of enhancing educational access and quality, the aforementioned logistical challenges further entrench existing inequalities and hinder the potential benefits of technology in education (Woldegiorgis 2022). These findings underscore the unintended consequences of technology adoption in South African higher institutions, highlighting the urgent need for targeted interventions to ensure equitable access and support for all students.

The literature also highlights the challenge of inadequate technological infrastructure within many South African universities, particularly those that are historically disadvantaged (Rudman 2021). The rapid transition to online education during the COVID-19 pandemic exposed critical weaknesses in the technology systems of many institutions. Many universities struggled to provide reliable Internet access and adequate technical support for both lecturers and students, resulting in a fragmented learning experience (Aruleba et al. 2022). This lack of infrastructure hindered the delivery of online education and highlighted the disparities between well-resourced institutions and those grappling with limited resources. Consequently, students from disadvantaged backgrounds faced substantial barriers to educational success, as they could not access the same quality of education as their peers in better-funded universities (Rudman 2021).

The implications of these challenges extend beyond the immediate educational context. The digital divide has significant ramifications for students' future employment opportunities. Those who are unable to develop necessary digital skills because of inadequate access to technology are at a disadvantage in an increasingly competitive job market that prioritises technological proficiency. As highlighted by Makua et al. (2023), this inequity perpetuates cycles of poverty and limits upward mobility for students from historically marginalised communities. The literature further noted that the fast pace of technology adoption in South African higher education has illuminated the paradoxical and unintended consequences of this erstwhile positive development (Chitimira & Hamadziripi 2022). The digital divide has not only hindered educational access and quality for disadvantaged students but has also created long-term implications for their employability and socio-economic advancement (Boughey & McKenna 2021; Woldegiorgis 2022). Agrawal, Sharma and Bhatnagar (2021) noted that South African higher education is in an epoch where digital literacy is paramount for educational attainment, leaving students with limited access to digital resources to grapple with challenges in aligning with technology-integrated curricula. This creates a potential knowledge gap with enduring implications, perpetuating societal imbalances into adulthood. Boughey and McKenna (2021) note that the contemporary workplace is increasingly digitised, and employers are actively seeking candidates with strong technological proficiency. However, graduates from under-resourced institutions often lack the necessary training and exposure to digital tools, hindering their ability to compete effectively for employment opportunities.

Recognition of unintended consequences of technology adoption in the broader South African context

Digital inequalities are recognised and discussed exhaustively in extant literature. Boughey and McKenna (2021) and Davids (2016) discuss digital inequalities, their role in the slow pace of transformation in South African higher education and ways to tackle the challenge. Ferrante et al. (2024) acknowledge the need to understand digital inequality in relation to other aspects of social inequality and emphasise the importance of moving beyond access and skills to consider the multilayered complexities of digital inequalities in education (Davids 2016; Ferrante et al. 2024). Given the incursion of technology into daily activities in South Africa, the digital divide has become increasingly apparent, notably in education and its subsequent impact on employment and entrepreneurial prospects. Individuals adept at leveraging the Internet and possessing advanced digital competencies tend to secure higher-paying jobs (Mn, Khalid & Husnin 2020). A stark contrast emerges between those navigating the digital landscape effortlessly and those facing challenges.

Khumalo and Saurombe (2023) also highlight the gender digital divide and the persistent gender disparities in access to digital resources and knowledge, particularly in South Africa. Mavuso and Olaitan (2024) discuss the deep inequalities between the Global North and the Global South, including sub-Saharan Africa, and contribute to the literature on digital inequalities in South Africa (Mavuso & Olaitan 2024). Although traditional media portrays young people as digital natives who can navigate the Internet and allied resources with ease, findings in scholarly literature refute this fallacy (Judd 2018). The reality alludes to a technological and structural imbalance which affects those economically disadvantaged significantly (Mhlanga & Moloi 2020). Studies by Kaba (2018) in South Africa also acknowledge the existence of digital inequality and the need to bridge the gap based on income levels. In consonance, Holmes and Burgess (2022) argue that digital exclusion is rooted in broader social and economic structural inequalities, including housing inequalities, and emphasise the need to look beyond access towards spatial and material factors that intersect with technological opportunities.

In agreement, Van Deursen and Van Dijk (2019) note that digital inequality is a multifaceted problem interconnected with pre-existing social, economic and cultural disparities within South African society.

Many individuals who use the Internet more intensively and in more skilful ways tend to earn more money once employed. They also stand a better chance of securing employment. The digital divide manifests prominently in education, where a person's education plays a critical role in their subsequent work placement and entrepreneurial abilities (Martens et al. 2020).

The intensity of Internet usage and Internet-related skills has significant implications not only for earning higher wages but also for influencing individuals' propensity to engage in entrepreneurial activity. Digital competencies, shaped by factors such as human capital, financial resources and cultural background contribute to both digital inclusion and entrepreneurship (Robinson et al. 2015). Ethnic and gender differences are also evident, with women entrepreneurs facing challenges such as smaller businesses, slower growth and difficulties in leveraging digital advantages for business success (Dinh, Dinh Hai & Pham 2023).

Entrepreneurial success in South Africa is increasingly dependent on the ability to adeptly employ modern technology to navigate the digital landscape (Botha 2019). Individuals with higher levels of connectivity and proficient Internet skills enjoy significant advantages in networking, client engagement, fundraising and business plan development (Botha 2019). Social media and mobile platforms have become essential tools for seeking and sharing information, contributing to the success of entrepreneurial ventures.

However, the digital divide in South Africa poses substantial challenges for many aspiring entrepreneurs. Individuals from disadvantaged backgrounds often lack access to reliable Internet and digital devices, which hinders their ability to fully participate in the digital economy, leading to significant disparities in business success and growth (Botha 2019).

Despite the rapid digital transformation across various sectors, a sizeable portion of the population remains offline, particularly in rural and underserved areas (Gillwald, Mothobi & Rademan 2018). The prohibitive cost of data and inadequate infrastructure further compound these challenges, making it difficult for individuals to engage with online resources. As Gillwald et al. (2018) highlight, the prohibitive costs associated with Internet access disproportionately affect low-income individuals, forcing them to allocate their limited resources carefully and often depriving them of valuable opportunities to develop essential digital skills.

Moreover, the lack of digital literacy among graduates further exacerbates their employability challenges (Okolie, Nwosu & Mlanga 2019). Many students, particularly those from disadvantaged backgrounds, do not possess the skills needed to navigate digital job search platforms or engage effectively with online application processes. Robinson (2012) emphasises that digital illiteracy can significantly hinder access to job opportunities, as many employers now require online submissions for applications.

Significance of addressing the unintended consequences of technology adoption in South African higher education

The adoption of technology in South African higher education has brought considerable progress, yet it has also unveiled a range of unintended consequences that must be addressed to promote equity, meet millennium development goals (MDGs) and enable opportunities for all students. Addressing these consequences is crucial for fostering an inclusive educational environment that aligns with the broader goals of social and economic development.

Promoting equity in education is a fundamental objective that technology adoption must support. However, the digital divide exacerbates existing inequalities, particularly affecting students from disadvantaged backgrounds who lack access to necessary digital tools and stable Internet connections, limiting their academic performance and future opportunities. By addressing these unintended consequences, educational institutions can ensure that all students, regardless of their socio-economic status, have equal access to the benefits of technology-enhanced learning. This approach aligns with social justice and equity principles, ensuring that no student is left behind because of technological barriers (Boughey & McKenna 2021).

Additionally, for South Africa to meet the MDGs, particularly Goal 4, which aims to ensure inclusive and equitable quality education for all, a concerted effort must be made to bridge the digital divide. The rapid integration of technology in education has highlighted the need for comprehensive strategies that address the socio-economic factors influencing access to digital resources.

Enabling opportunities for all students is another significant aspect of addressing the unintended consequences of technology adoption. The modern workforce increasingly demands technological proficiency, and students lacking digital skills are disadvantaged in the job market. By integrating digital literacy training into higher education curricula, institutions can prepare students to meet the demands of the evolving job market. This preparation not only enhances their employability but also contributes to their socio-economic mobility. Ensuring that all students have the opportunity to develop these essential skills is vital for fostering a more inclusive and equitable society (Okolie et al. 2019).

Collaborative efforts among educational institutions, government and industry stakeholders are essential to address these challenges effectively. Such partnerships can facilitate the development of policies and initiatives that promote digital inclusion and support students from disadvantaged backgrounds. By working together, stakeholders can create a more supportive environment that empowers all students to succeed, regardless of their socio-economic status. This collaborative approach is crucial for mitigating the unintended consequences of technology adoption and ensuring that its benefits are accessible to all (Rudman 2021).

Recommendations for mitigating unintended consequences of technology adoption in South African higher education

Mitigating the unintended consequences of technology adoption in South African higher education requires a multifaceted approach that addresses digital inequalities, enhances digital literacy and fosters collaborative efforts among stakeholders. These actionable steps are essential to promote equity, meet MDGs and enable opportunities for all students.

Investment in digital infrastructure is paramount, particularly in underserved areas where access to reliable Internet and digital devices remains a significant barrier. Critics may argue that resources should be allocated to enhance traditional educational methods rather than focusing solely on technology. However, it is crucial to recognise that a robust digital infrastructure is foundational for modern education (Makua et al. 2023; Padayachee 2017). The initial costs associated with such investments may be substantial, but they are necessary to ensure that all students can participate in an increasingly digital learning environment.

Implementing comprehensive digital literacy programmes is vital for equipping students and educators with the skills to navigate and effectively utilise digital technologies. While there is a valid concern that a standardised approach to digital literacy may not meet the diverse needs of all learners, tailored programmes that account for varying levels of prior knowledge can enhance engagement and success (Faloye & Ajayi 2022). By fostering digital competencies, students will be better prepared to leverage technology for their academic and career advancement, mitigating the risk of widening the digital divide.

The provision of targeted support for disadvantaged students is essential to ensure equitable access to technology-enhanced education. Although some may argue that financial aid and mentorship programmes alone cannot address the systemic issues of poverty and inadequate prior education, these initiatives are critical steps towards levelling the playing field (Boughey & McKenna 2021). By offering financial assistance for digital devices, access to on-campus resources and peer mentorship, universities can help bridge the gap for students from diverse socio-economic backgrounds, thus mitigating the unintended consequences of technology adoption that could otherwise exacerbate existing inequalities.

Collaborative efforts among educational institutions, government and industry stakeholders are vital for developing policies that promote digital inclusion (Menon & Castrillón 2022). The potential benefits of coordinated efforts to enhance digital infrastructure are key to mitigating the unintended consequences of technology adoption in South African higher education (Moyo & Munoriyarwa 2021). By aligning the interests of various stakeholders, educational institutions can better address the specific needs of their students and communities, ultimately mitigating the unintended consequences of fragmented or poorly implemented technology initiatives.

Promoting inclusive and equitable educational policies is necessary to tackle the broader socio-economic factors that contribute to digital inequality. Although policy changes often take time to implement and may face political hurdles, prioritising initiatives that reduce the cost of Internet access and digital devices is essential for creating an inclusive educational environment (Davids 2016). Addressing these structural barriers will enable historically disadvantaged institutions to implement effective technology-enhanced learning, thereby mitigating the unintended consequences of unequal access to educational resources.

Continuous monitoring and evaluation of technology adoption initiatives are critical for identifying and addressing any emerging unintended consequences. A feedback mechanism for collecting insights from students and educators is fundamental for informing ongoing improvements. Regular research on the impact of technology adoption on student outcomes will ensure that these initiatives achieve their intended goals and contribute to a more equitable educational landscape, effectively mitigating the risks associated with technology integration.

In summary, while the path to equitable technology adoption in higher education presents challenges, a comprehensive approach that includes investment in digital infrastructure, implementation of digital literacy programmes, targeted support for disadvantaged students, collaboration among stakeholders, inclusive policies and ongoing evaluation can significantly enhance the educational experience for all students in South Africa. By addressing these multifaceted issues and actively working to mitigate unintended consequences, higher education institutions can create a more equitable and inclusive environment that fosters success in a rapidly evolving educational landscape.

Conclusion

This chapter discusses the unintended consequences of the swift and rapid adoption of technology in South African higher education, particularly accelerated by the COVID-19 pandemic. It highlights how this transition has exacerbated existing socio-economic disparities, leading to significant digital inequalities. These inequalities manifest in various forms, including limited access to devices and Internet connectivity, variations in digital literacy and the psychological impact on students and educators. The chapter emphasises the need for comprehensive strategies to mitigate these unintended consequences. This includes investing in digital infrastructure, providing targeted digital literacy programmes and fostering collaborative efforts among educational institutions, government and industry stakeholders.

In conclusion, this chapter reiterates that while the adoption of technology in higher education holds the promise of enhancing educational access and quality, it is imperative to address the digital divide and other structural inequalities to ensure equitable opportunities for all students. By recognising and proactively addressing these unintended consequences, South African higher education can harness the transformative potential of technology to promote social mobility, reduce inequalities and contribute to the development of a skilled workforce capable of thriving in a technology-driven global landscape. This chapter serves as a call to action for policymakers, educators and stakeholders to create an inclusive and equitable educational environment that leaves no student behind.

Building on the themes discussed in Chapter 9, Chapter 10 explores the role of service providers in shaping digital services and addressing digital inequality. It underscores the importance of accessibility, inclusivity and reliable service, aligning with the chapter’s call for equitable opportunities. By implementing best practices and addressing challenges in rural areas, service providers can contribute to reducing the digital divide and fostering socio-economic growth. This, in turn, supports the broader goal of creating an inclusive and equitable educational environment.

Chapter 10

Role of service providers in shaping and advancing digital services in southern Africa: A case study

Godwin P Dzvapatsva
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Courage Matobobo
Department of Business and Application Development,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

Prince DN Ncube
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

David T Risinamhodzi
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
East London, South Africa

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Abstract

This chapter explores the critical role of service providers in advancing digital services in southern Africa, focusing on their impact on digital access, inclusion and socio-economic development. It highlights the role of government telecommunication companies as policymakers and key providers of fixed lines, essential for digital service delivery. The chapter employs Penrose's resource-based theory to understand the management of resources, diversification and innovation in the digital services sector. It posits that digital service providers (DSPs) can reduce digital inequality and foster inclusive access to digital technologies in underserved communities by applying resource-based value concepts. Data from four case studies of state-owned telecommunication companies in southern Africa demonstrate significant progress, particularly in urban areas. However, the data also reveal political interference in resource allocation, price fixing and fraudulent activities, as digital spaces attract high-paying tenders. Despite evidence that digital innovation enhances a nation's socio-economic status, digital inequality persists because of providers' reluctance to invest heavily in rural areas with lower profit margins. The chapter concludes with best practices for DSPs to reduce digital inequality and recommends future studies on independent DSPs. It also suggests crafting digital frameworks that ensure the sustainability of communities and nations.

Introduction

The role of service providers in southern Africa's digital services ecosystem has grown critical in this digital transformation era. This chapter digs into southern Africa's diverse digital services sector, examining how service providers shape and influence this rapidly expanding domain. This chapter builds on the previous discussion in Chapter 9, which delved into mitigating the unintended consequences of digital inequality in South African society. By linking the two chapters, we aim to provide a comprehensive analysis of how effective service provision can address digital disparities and contribute to broader socio-economic development. While Chapter 9 focused on strategies to counteract the negative impacts of digital inequality, this chapter highlights the proactive measures and innovations by service providers essential for fostering digital inclusion and sustainability in the region. Service providers, notably Internet Service Providers, are at the centre of this digital transformation, playing a critical role in facilitating the provision of digital services across sectors. Digital service providers are companies that create, promote 'and sell digital services based on software or digital data or whose services are available in digital format' (Gabrielsson et al. 2021; Ojala, Evers & Sousa 2022). Examples of DSPs in southern Africa include Vodacom (South Africa), MTN Group (South Africa), Econet Wireless (Zimbabwe), Telkom (South Africa), NetOne (Zimbabwe), Cell C (South Africa), Mozambique Cellular (Mozambique), Orange Botswana (Botswana), Unitel (Angola) and MTN Zambia. These providers play a crucial role in shaping the region's digital landscape. Digital services are 'Internet-based applications that fulfil service needs by seamlessly [connecting] distributed, specialised resources to enable [complicated (sometimes] real-time) transactions' (Tiwana & Ramesh 2001 in Foko, Phiri & Mahwai 2014). Mobile banking, e-commerce, digital health services and e-government initiatives comprise southern Africa's digital services landscape. These digital services are consumed by consumers such as community members, government departments, profit-making organisations, banks, non-profit organisations (NPOs) and schools.

The role of service providers in providing digital services in southern Africa is crucial for the socio-economic growth of the region. While advances in digital technology provide the potential for innovation and increased connectivity, some hurdles and discrepancies prevent these benefits from being fully realised (Atkinson & Mckay 2007; Goundar 2011). The issue is the uneven distribution of digital services, insufficient infrastructure and the accessibility divide, all of which contribute to digital inequality and impact service delivery across multiple sectors (Robinson & Gahagan 2010; Salemink, Strijker & Bosworth 2017).

Understanding the role of DSPs is critical for successfully navigating the intricacies of today's digital ecosystem. These service providers form the backbone of the digital economy, influencing how we access information, communicate and interact with services. Policymakers, corporations and consumers all need to understand their roles. Policymakers can create effective rules that balance innovation and consumer protection, creating a climate conducive to economic progress. Businesses can use this knowledge to stay competitive by strategically aligning with technological developments. Understanding the roles of service providers enables consumers to make informed decisions regarding digital services, ensuring they correspond with personal interests and beliefs. Furthermore, understanding the role of DSPs is critical for resolving digital inequality, encouraging diversity and constructing a resilient, secure and privacy-protecting digital infrastructure. In essence, recognising these responsibilities is critical on economic, societal and technological levels, defining the direction of our increasingly digital society.

To gain more knowledge of the function of DSPs within the larger digital ecosystem, this chapter has focused on telecommunication service providers. Telecommunications service providers serve as the backbone of digital connectivity, providing the infrastructure and networks enabling diverse digital services. The chapter's focus is on this specific sector to unearth the complexities of how these providers offer access to digital services such as Internet connectivity, voice communication and data transmission. Furthermore, telecommunications firms frequently serve as major enablers for upcoming technologies such as 5G, which are critical for the next stage of digital transformation. Investigating the role of telecommunications service providers provides useful insights into the digital landscape's issues, opportunities and strategies. Understanding their role is critical for developing successful regulations, encouraging innovation and ensuring digital services are accessible and inclusive to people of all backgrounds and geographies.

Definition of key terms

In the context of digital services in southern Africa, no discussion can pass without discussing the digital divide and digital inequality. Islam and Inan (2021) define digital inequality as the disparity in digital services, skills and knowledge across people of different socio-economic backgrounds, demographics, information technology (IT) experiences and other aspects. We define the digital divide as the gap between people with access to digital services such as the Internet and digital devices and those without. Distinguishing between the digital gap and digital inequality is critical when evaluating the role of DSPs in addressing these concerns because they represent different parts of the challenges associated with digital access and usage. Understanding these disparities enables precision in problems identified by stakeholders and availing tailored interventions to communities.

Digital services

According to Saleem et al. (2021), digital services are 'the electronic transfer of information, including data and content, across numerous platforms and devices like the web or mobile'. These services frequently use technology to provide value to individuals, corporations or organisations. It is essential to note that digital service rides on the backbone of the Internet. Digital services can include a wide range of offers, and they are becoming more common in today's technologically driven environment. Increasingly, organisations are using digital platforms for engagement with wider communities that might find it difficult to reach through physical and location-based services. Digitally enabled companies have an edge over those who continue to operate their organisation traditionally. Many services can now be accessed digitally, including m-banking, m-learning, m-health, m-governance and m-agriculture. In recent years, technological and business convergence has resulted in the proclamation of digital transformations across all fields, resulting in breakthroughs and new e-services solutions available on mobile devices, giving rise to m-services. Digital services evolve as technology advances, offering new ways for individuals and businesses to connect, transact and access information and resources. Digital services can include a wide range of offers, and they are becoming more common in today's technologically driven environment. Digital service encompasses multiple stakeholders.

Stakeholders

Stakeholders in digital service provision are individuals, groups or entities that have an interest, influence or are affected by the delivery and performance of digital services.

Service providers

Service providers are organisations or businesses that provide specific services to individuals, corporations or other entities, addressing various needs from telecommunications and technology to health care, finance and other fields. The phrase 'service provider' is broad and can refer to multiple industries and business models, reflecting how firms provide services to their target clients. In this chapter, we use the term DSPs to refer to a conveyor belt of digital service innovations on digital platforms (Setzke et al. 2023). The role of DSPs in the supply, maintenance and success of digital services is diverse. Their contributions span the whole lifecycle of a digital service, from infrastructure and software development to security, marketing, customer support and compliance. The quality and dependability of the service providers engaged often determine the effectiveness of these services. Table 10.1 shows some of the different DSPs in southern African countries, but the list is not exhaustive.

Governments

The government's role as a stakeholder is multidimensional as well because it oversees not only the regulatory frameworks but also the telecommunications entity in most countries. This has been a source of conflict on occasions where their telecommunications corporation has attempted to squeeze out smaller suppliers.

Service providers may operate on a subscription or contractual basis, and their success often depends on their ability to deliver quality services, meet client needs and adapt to changing market conditions (Gittell 2002).

TABLE 10.1: List of digital services.

Digital service	Explanation	Example
Telecommunications providers	Infrastructure, cybersecurity and hosting (ISP, communication services)	Telkom, Afrihost, Cool Ideas (SA), TelOne (Zimbabwe), Liquid Intelligent Technologies, BTC, Mascom-Wireless (Botswana), MTN, ZAMREN (Zambia), Malawi Telecommunications, Simbanet (Malawi), etc.
Content delivery network providers	Streaming and publishing	Cloudflare, CacheFly, AFR-IX
Social media platforms	Social networks, messaging	Facebook, WhatsApp, X
Software deployment/cloud service providers	IaaS, PaaS, SaaS, CaaS	Amazon Web Services, Microsoft Azure, IBM Cloud, Google
e-Commerce platforms	Market platforms	Amazon, eBay, Takealot
Government/municipalities	Utilities service provision, voting, tax, etc.	efiling, e-billing
Banks/insurance	FinTech	WorldRemit, Banks, Mukuru, etc.
Customer support and training	Global process outsourcing	Teleperformance (SA)

Source: Author's own work.
Key: ISP, Internet Service Providers; BTC, Botswana Telecommunications Corporation; IaaS, Infrastructure as a Service; PaaS, Platform as a Service; SaaS, Software as a Service; CaaS, Container as a Service; FinTech, Financial Technology.

Other stakeholders

Business enterprises are among the key consumers of digital services, but ultimately, individuals are at the end of the digital service lifecycle. Other stakeholders can be non-governmental organisations as they play a part in addressing the inherent inequality created by colonial masters. We have also observed churches playing an essential part in the supply of digital services during the coronavirus disease 2019 (COVID-19) pandemic, attempting to close material access (Van Deursen & Van Dijk 2019) inequities in schools and poor communities. Further, companies that offer technologies, tools or services to supplement or support digital services are also important stakeholders. In this chapter, we concentrate on telecommunications companies and individuals as the stakeholders in the digital service ecosystem. We believe that telecommunications businesses offer the foundation for digital services.

Current states and trends in digital services provision in southern Africa

Digital services in southern Africa are dynamic, characterised by exponential growth and tremendous challenges. In this section, we discuss the current digital services provision in southern Africa and highlight the trends. Table 10.2 depicts a slight rise in the percentage of users in each country, with Zimbabwe experiencing the greatest growth and Eswatini experiencing

TABLE 10.2: Current state of digital services in parts of southern Africa.

	Botswana	Namibia	Zimbabwe	South Africa	Eswatini
Population	2.65m	2.58m	16.49m	60.14m	1.21m
Internet users	1.95m	1.37m	5.74m	43.48m	710.3k
Internet penetration	73.5%	53.0%	34.8%	72.3%	58.9%
Social media users	1.1m	729.2m	1.50m	25.80m	335.9k
Cellular mobile connection	4.28m	2.81m	14.08m	112.7m	1.28m
Rural population	72.5%	45.7%	67.5%	31.4%	75.3%
Urban population	27.5%	54.3%	32.5%	66.8%	24.7%
Male population	50.6%	48.2%	47.2%	48.7%	49.6%
Female population	49.4%	51.8%	52.8%	51.3%	50.4%
% increase of internet users	1.7%	1.4%	2.10%	0.80%	0.7%
Not using internet	703k	1.21m	10.75m	16.66m	495.6k
% remained offline as of Jan 2023	26.6%	47%	65.2%	26.7%	41.19%
Internet connection speed cellular	33.05 Mbps	18.30 Mbps	10.88 Mbps	36.70 Mbps	–
Fixed Internet connection	7.52 Mbps	8.28 Mbps	8.52 Mbps	40.12 Mbps	5.15 Mbps

Source: Authors' compilation adapted from https://datareportal.com/reports/?tag=Global+Overview.
Key: m, million; K, thousand; Mbps, Megabits per second; Jan, January.

the least. Most people in Botswana, Zimbabwe and Eswatini live in rural areas, while most people in Namibia and South Africa live in urban areas. These countries have a wide range of cellular connection speeds, with South Africa having the fastest speed of 36.70 Mbps and Zimbabwe having the slowest speed of 10.88 Mbps.

Despite digital inequities, we should commend governments, DSPs and all other role players for significantly improving the provision of digital services over the past five years (Begazo, Blimpo & Dutz 2023). As organisations and academic institutions attempted to continue daily operations during the COVID-19 pandemic, digital services became more important. To work from home, extensive infrastructure was required and organisations made frantic efforts to ensure the smooth running of the organisations by providing devices and data.

Theoretical underpinning

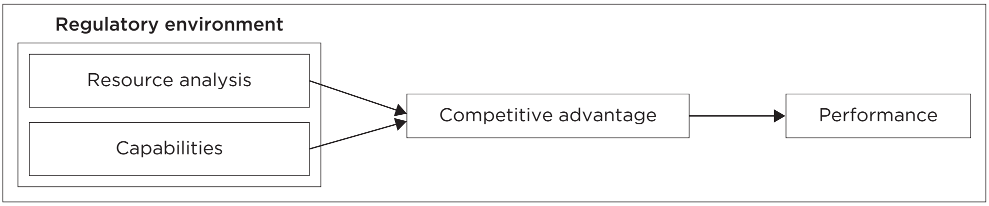
To give our chapter a solid theoretical frame, we adopted Penrose's resource-based value theory (Burvill, Jones-Evans & Rowlands 2018) to understand the effective management of resources, diversification and innovation for productive opportunities within the digital services sector in southern Africa. The resource-based view emphasises an internal organisational approach, asserting that a firm's performance is driven by its unique resources and capabilities. The framework consists of three concepts: competitive advantage, resource analysis and capabilities, which are discussed in this section.

Resource analysis

This chapter asserts that digital service provision largely depends on resource analysis by telecommunications companies and government policies. Resources, defined as all tangible or intangible elements that can be utilised in telecommunication organisation processes to create and develop products and provide services, and capabilities, which refer to the recurring action patterns used to leverage these assets effectively, are crucial for this analysis (Wade & Hulland 2004). Resource analysis enables organisations to examine specific resources, identify areas requiring infrastructure and allocate financial capital for training and upskilling users, thereby reducing digital inequality. Proper analysis of resources helps understand how these assets can be used to develop and deliver advanced digital services. While there are critics of this theory regarding how firms integrate resources for innovation (Kraaijenbrink, Spender & Groen 2010), this chapter posits that understanding resource analysis is foundational for meaningful strategic identification of areas requiring such assets and their future utilisation. Several cases of infrastructure lying idle have been reported in parts of South Africa where governments have acquired resources already in existence for political campaigns, and the infrastructure ends up being vandalised (Ditlhake 2022; Mzekandaba 2021; SALGA NEWS 2023).

Capabilities

The capabilities component of the resource-based value framework plays a significant role in digital service provision, as it determines how effectively a telecommunications company can leverage its assets. The resource-based value theory uses the term capabilities to refer to the organisational ability to deploy resources effectively to achieve desired outcomes, one of which is a competitive advantage. In the context of digital services, these capabilities enable organisations to optimise their processes, develop new products and efficiently respond to market demands. Effective capabilities facilitate seamless integration of technology, enhance user experiences, and ensure the scalability and reliability of digital services. Therefore, a company's ability to harness its capabilities directly influences its competitive advantage and success in the digital marketplace. As several key players have joined the telecommunication landscape in most southern African countries, it is crucial for organisations to always think of dynamic capabilities that foster innovation and competition.



Source: Author's own work.
FIGURE 10.1: Resource-based value theory for digital services.

Competitive advantage

Competitive advantage, a key concept in this chapter, typically refers to distinctive and unique resources that are durable, challenging for competitors to replicate, and valuable within the firm's environment and marketplace (Birkinshaw & Goddard 2009; Madhani 2010). The telecommunication landscape in southern Africa has been largely dominated by the monopoly of partially or fully state-owned entities, and therefore, they never faced competition. Perhaps it explains why digital inequality is more pronounced than in developed countries, and such companies saw no need to innovate as the landscape was not competitive markets. Thomson Reuters (2023) suggests that many companies prioritise their capacity to innovate, as innovation is crucial in highly competitive markets.

As depicted in Figure 10.1, our approach suggests that resource analysis and capabilities determine an organisation's competitive advantage, ultimately affecting performance. Resource analysis and capabilities are guided by regulatory environments, which could be municipal policies in the areas where the companies want to invest. There have been instances in various parts of South Africa where residents, through their community leaders, have protested the placement of network towers without consultations, citing concerns about potential health risks to the residents. The three concepts in resource-based theory are essential for understanding digital service provision and evaluating their impact on the overall advancement of digital services in the region.

Methodology

The chapter examines case studies from four southern African countries: Zimbabwe, South Africa, Botswana and Namibia. These countries were selected because of their significant digital transformation levels and efforts to address digital inequality. The selection was based on access and data availability regarding these aspects in southern Africa. The selected countries represent southern Africa's digital services landscape well. We examine government telecommunication companies' data on their websites and government reports. In our analysis of documents and reports, we focus on the following issues: ownership of the largest telecommunication companies in each selected country, infrastructure services, monopolies, partnerships and device access. The findings under major sub-themes such as ownership, device access assistance, infrastructure contributions, partnerships, and collaboration are summarised in the section 'Case of South Africa'.

The case studies presented in this chapter focus primarily on government-owned telecommunications service providers. As these entities are the primary providers of digital services and were among the first to receive licences, they are considered pioneers in their field. The chapter presents case studies from the following countries and their respective telecommunications service providers:

- South Africa: Telkom
- Botswana: Botswana Telecommunications Corporation (BTC)
- Zimbabwe: TelOne
- Namibia: Mobile Telecommunications Company (MTC).

The results from the different cases are discussed in the section 'Case of South Africa' under the following themes: ownership of the largest telecommunication companies, the development and provision of infrastructure services, the presence of monopolies, strategic partnerships and the accessibility of digital devices as selected for each country. By linking these aspects, research can provide a holistic view of how DSPs operate within the telecommunications ecosystem and how various factors influence their effectiveness and reach. These factors collectively contribute to digital inequality, as disparities in these areas lead to uneven access to affordable, high-quality digital services and devices across different populations and regions.

Case of South Africa

Ownership

In this chapter, we focused on Telkom, a government-owned telecommunications company with a clear mandate to provide infrastructure and enhance digital service accessibility. Telkom South Africa was established as a state-owned company in 1991, with the government retaining a significant stake in the shares. As of a Mybroadband report dated 29 July 2023, the government effectively controls Telkom, owning 40.51% in its name, and the Government

Employees Pension Fund (GEPF) owning 13.6%, giving the government an effective stake of 54.11%. Telkom was born out of the Department of Posts and Telecommunications (DPT), which was split into Telkom and the SA Post Office on 01 October 1991. Telkom has numerous subsidiaries, such as Telkom Mobile, Business Connexion Group, Trudon (Pty) Ltd, Openserve and many others.

Infrastructure services

> South Africa's Telkom announced (in 2020) plans to replace its copper local broadband infrastructure with fibre (to) improve speeds, reduce maintenance costs and resolve the issue of copper cable theft. (Burkitt-Gray 2020, p. 1)

Through its subsidiary:

> Openserve operates around 170 000 km of fibre and legacy landline copper cables. The government's Broadband Infraco manages 14 862 km of fibre, making it the second-largest fibre network operator in the country. (Prinsloo & Cele 2023, p. 2)

Openserve had a fibre-to-the-home (FTTH) connectivity rate of more than 46% in 2022 (Moyo 2022).

Most of the nation's fixed-line infrastructure is still provided by Telkom, which also engages in downstream markets (Robb 2020). A primary obstacle to the rollout of mobile networks was Telkom's long-standing monopoly on leased lines, which was extended by the *Telecommunications Act of 1996* (Sutherland 2021). Although mobile operators were allowed to construct their own infrastructure starting in 2002, this was initially meant to be a cash cow to support infrastructure development for underserved communities, which had been abused by overcharging service providers for many years (Sutherland 2007).

As of the end of 2016, Vodacom held the top consumer market share among mobile communications companies in South Africa, followed by MTN with 34.9%, Cell C with 17.3% and Telkom with 4.5% (BusinessTech 2017). As of 2014, Telkom's mobile division, 8ta, offered prepaid mobile broadband with a maximum speed of 21 Mbps for less than US$24 a month (Stork, Calandro & Gamage 2014).

Service monopoly

The government established policies and legislation to ensure that Telkom, the only fixed-line service provider in South Africa, offers citizens reasonably priced access to the country's telecommunications infrastructure at a satisfactory level of service (Ponelis & Britz 2008). Nevertheless, Telkom has taken advantage of its market monopoly rather than carrying out its duties to the South African government and citizens (Ponelis & Britz 2008). In addition, Telkom has significantly raised its profit margin over the past few years and reduced its employment by more than half. While we can say broadband subscribers increased to 11 million (fixed broadband at 500 000 and mobile at 10.5 million), with 79% of them enjoying fast speeds of up to 10Mbps or faster, which allowed for increased data use (Moyo 2022), there is still a genuine issue of sector bullying from Telkom. Without competition, service providers continue to drive prices higher, providing limited services to the citizenry, further exacerbating digital inequality.

Telkom SuperCentres Project

Telkom SA (Telkom) pledged in 1998 to supply South African schools with 1000 Internet access points. The Telkom 1000 Internet Schools project was finished in 2000, and SchoolNet SA was contracted to conduct site visits and provide training from October 1999 to June 2000 (ITWeb 1999).

Partnerships and collaboration

Digital service providers increasingly recognise the importance of partnering with other entities to ensure the successful provision of digital services. In South Africa, in collaboration with the University of Witwatersrand, Telkom launched a commercial Research and Development (R&D) centre known as the Telkom Industry Solutions Lab to foster synergistic engagement between industry and academia (Wits University News 2023). This initiative is commendable, aligning with our adopted framework that emphasises the competitive advantage aspect of the resource-based value. By leveraging unique partnerships with universities, the organisation ensures that stakeholders, such as customers, benefit from these collaborations, which are difficult for other telecommunication companies to replicate. This can potentially trigger innovation from competitors, resulting in improved digital services for customers.

Device access

In addition, the Telkom Foundation, in collaboration with the Department of Basic Education (DBE), outfitted the classrooms of specific schools with DBE-approved gadgets and equipment, such as wireless microphones, video cameras and light-emitting diode (LED) display monitors (BR Reporter 2022). This initiative aimed to provide 1100 students and 30 teachers with the ICT know-how and tools they would need to prosper in a world that is becoming more and more virtual.

Youth Employment Service and Telkom collaborate to provide 499 youth with the chance to enter the workforce and acquire skills relevant to the rapidly expanding ICT industry (IOL Reporter 2022). As the nation attempts to stop the virus's spread, Telkom offers zero-rated educational uniform resource locator, such as the Technical and Vocational Education and Training colleges, and higher education institutions to assist young people in accessing education (Telkom n.d.).

Challenges and potential solutions

According to Gillwald (2005), the high fees internet service providers (ISPs) and other value-added service providers have to pay Telkom for the use of its network, along with Telkom's delays in providing facilities and interconnection to these value-added network services (VANS) providers, have hindered people's access to the Internet. Additionally, Telkom has refused to grant VANS operators access to the international data bandwidth they require to properly service their clients and rival Telkom's value-added data service offerings (Gillwald 2005).

To alleviate the challenges, the following remedial measures are highlighted:

- *Reduce the monopoly by altering policy because increasing competition makes services more affordable and puts pressure on operating margins*
  The lack of effective competition in the backbone services market allows Telkom to maintain high wholesale prices for backbone services, as noted in Nigeria's case (Williams 2010).
  The disruption of the BTC monopoly in 1996 is a perfect example of how breaking the monopoly of backbone network provision can be beneficial to the ISPs and, consequently, the citizens of the country at large (Sebusang, Makepe & Botlhole 2007).
- *Investment in network infrastructure*
  Telkom has long been the sole provider of backbone services, so it does not need to be competitive and has neglected to improve its infrastructure continuously. Antiquated infrastructure leads to several drawbacks that affect the ISP's service provision. Hardware refreshes could be required to improve the quality of service provision, thereby mitigating network traffic congestion, delays, etc.
- *Promote infrastructure sharing to lessen the financial burden*
  The cost of hardware is significant, and hardware costs tend to be crippling when left unchecked. Internet Service Providers and VANS providers could partner up and share infrastructure costs by engaging in infrastructure sharing. The same applies to Telkom in that sharing some of the costs of the infrastructure with some of the big names in

ISP provision, such as Link Africa and Afrihost, could improve their service delivery and be in a position to roll out some of the infrastructure that has long been needed in the remotest of areas in South Africa.

The following approaches could also mitigate the financial burden of ISPs and VANS providers/operators:

- *Investing in renewed hardware (save up to 50%–70% on IT costs)*
  Instead of wasting funds on brand-new material, costs can be limited by getting renewed hardware (hardware that has been returned to the manufacturer or a third-party seller who inspects, cleans and repairs the hardware as needed, restoring the hardware to its near-original state (most of the time the hardware is improved to meet the latest required standards [upgrading]).
- *Choose from hardware support options (and build a hybrid maintenance strategy)*
- *Opt for aftermarket support (and avoid recurring hardware refreshes)*
  Get hardware and software with aftermarket support to avoid paying for hardware refreshes when the technology becomes obsolete and requires changing.
- *Streamline multiple vendor servicing contracts (to simplify IT operations)*
- *Partner with professional service providers (and skip the effort of building an in-house team)*

The subsequent reduction in financial strain would benefit their customers, that is, the citizens of South Africa whom Telkom has been mandated to service.

Case of Botswana

Ownership

Botswana Telecommunications Corporation is a telecommunications and ISP founded in 1980 to create, maintain and expand the country's national and international telecommunications networks. Botswana Telecommunications Corporation was the sole telecommunications operator in Botswana until 1996 when an amendment to the BTC Act ended BTC's monopoly and permitted indirect competition from two cellular businesses, MASCOM Wireless and Orange (Natarajan et al. 2016). In 2012, the government then split BTC into two subsidiaries: Botswana Fiber Networks (BoFiNet), a 100% government-owned company that took over backbone fibre infrastructure access (to be given to all operators on equal-access wholesale rates) and BTC, the PTO for retail and due for privatisation (Esselaar & Sebusang 2013).

Infrastructure services

Botswana Telecommunications Corporation has finished the multimillion-dollar Pula TransKalahari fibre optic project, which spans over 2000 kilometres and is used to transmit electricity, voice and data transmissions (Mbo & Adjasi 2017). The company also operates a rural connectivity initiative to link 62 (Mbo & Adjasi 2017).

Botswana Telecommunications Corporation has improved network coverage from 2G to 4G LTE in 45 settlements in the Okavango and Northwest regions of the country (Maramwidze 2023). Botswana Telecommunications Corporation introduced BeMobile, the third mobile telephony provider, in 2008, and by 2009, many individuals in Botswana had adopted and begun to use mobile phones (Lesitaokana 2014). Botswana Telecommunications Corporation quickly expanded its service area throughout Botswana, allowing it to acquire a significant subscriber customer base (Lesitaokana 2014).

To achieve a more prosperous future for all of Batswana, the BTC, in partnership with the Universal Access Service Fund (UASF), will invest in communication infrastructure to enhance network coverage and promote communities' migration to the digital sector (Mmolai n.d.). Fibre has been installed in major towns around the country, including Gaborone, Jwaneng and Orapa (BCT Report 2022).

Devices access

According to Lesitaokana (2014), as part of its community obligation, BTC provided goods and services such as public pay phones, fixed landline phones for families and companies, telephone equipment, and technology strategies and network management for Botswana's telecom industry. Botswana Telecommunications Corporation collaborates with technical partners such as Huawei Technologies Botswana and Vodafone Group on training programmes as part of digital literacy initiatives.

Service monopoly

The telecommunications monopoly ended in 2012 (Esselaar & Sebusang 2013), with further role players being allowed in the digital space.

Partnerships and collaboration

Residents of the Okavango region were allowed to participate in a stakeholder engagement session discussing the network expansion project performed in their area by BTC Limited at Shakawe Kgotla. With this project, BTC has linked local communities, health posts, kgotlas and schools (BTC News 2023). As part of the celebration of this historic milestone with the Okavango community, Shakawe Kgotla received a complete computer set worth 9000 pula (approximately US$65) from BTC through its Foundation. The computer in the kgotla office will be utilised for daily operations when assisting the public. Furthermore, BTC donated an e-learning package to Ngambao Junior Secondary School in Seronga (BTC News 2023).

Challenges and potential solutions

Half of the world's population, which has no access to the Internet, includes many Botswana citizens (Mokeresete & Esiefarienrhe 2020). People far from administrative centres experiences less efficient networks because of power connections, and others lack access because of high tariffs (Broom 2020). According to Vision 2036 Presidential Task Team (Botswana) (2016), impoverished countries have only linked roughly 47% of their people, with Botswana being one of them. In Botswana, the lack of online government services, online education services and online health services means that youth, unemployed people and many communities across the country lack access to essential services. According to the report, the underlying causes of Botswana's failure to achieve viable cheap broadband services and access are high transit costs and a lack of legislative and regulatory framework issues. Digital inequality is evident in Botswana's data regarding digital service provision. As a result, while the country is viewed as performing well in other areas, it lags in providing digital services.

Establishing a full-time national broadband strategy secretariat through the statutory mechanism is necessary to provide decision-making authority and responsibility. The government must also accelerate the construction of the Government Data Network and Government Data Centres to fulfil demand.

The case study revealed that Botswana still has a lot of work to do, especially in rural areas, where the digital divide is still apparent compared to urban areas. The lack of access to electricity in these remote areas continues to derail service provision in the remote regions of Botswana. The deployment of satellite and cellular broadband Internet service provision could be the most feasible approach to alleviating the lack of Internet access because of a lack of electricity. Often, remote areas have rugged terrain that makes it complicated to install fibre at an economical rate to allow profits and sustainable business in these areas. Consequently, satellite and broadband have become cheaper options and, therefore, much more feasible for serviing the constituents of these areas.

Case of Zimbabwe

Ownership

Since colonial times, the Posts and Telecommunications Corporation (PTC) has served as Zimbabwe's telecommunications regulating authority. The telecommunications regulator was a political agency directly overseen by the executive of government, and its appointments were both a political sinecure and a way of securing control of public assets (Howard & Mazaheri 2009). Commendable that in the year 2000, the commercialisation of PTC led to the formation of three subsidiaries: TelOne, a fixed telecommunications provider, Net One – a mobile network providing a cellular network and ZimPost – a postal services company. The Zimbabwean government owns 100% of TelOne Zimbabwe, which is managed by the Ministry of Information Technology and Courier Services (Zambasa 2022).

Infrastructure services

TelOne inherited a debt that stood at US$374 million as of October 2017, which continued to haunt the company and has been further exacerbated by the economic challenges faced by the country. They still have to use forex services to connect to other networks outside the country. With limited forex reserves, no organisation can sustain the situation unless massive flows of resources are channelled towards digitisation. Because of the inherited debt, fixed line subscribers fell from 302 000 to 264 000 between 2012 and 2017 (African Development Bank Group 2019), but contract mobile subscriptions rose by 35% by 88.1% of fixed line subscribers, with Harare leading the other urban areas by 8.7%.

TelOne offers users Internet access via dial-up and the latest asynchronous digital subscriber line (ADSL) technology (Chivandi, Mutanga & Musungwini 2014). TelOne is linked to two undersea cables in the Indian Ocean: the East African Submarine Cable System (EASSy) cables and the West Africa Cable System (WACS) cables (African Development Bank Group 2019). To capitalise on the rapid advancement of technology, the Zimbabwean government, in collaboration with TelOne, has continued to develop projects to improve Internet connectivity throughout the country via the Makuti-Chirundu fibre optic link (Sunday News 2020).

Even though network vandalism affects 30 000 users, TelOne has invested $2.4 million in the most recent upgrade of its broadband network to increase capacity and lower connectivity latency (Karombo 2023). TelOne has begun to expand fixed network infrastructure, including deploying fibre optic infrastructure, microwave network infrastructure and satellite communication equipment.

Device access

One of Mugabe's most well-known achievements, in partnership with the Zimbabwean government, was distributing computers to schools nationwide. While opponents of the ruling party argued that this was a form of vote buying, it ultimately expanded access to digital gadgets at the time. Such initiatives are commendable and must be continued, but of course, there is also a requirement to assess the existing infrastructure, such as electricity, and ensure that teachers are digitally literate.

Service monopoly

The government dissolved the monopoly in 1997 by licensing two mobile providers: Econet and Telecel. Strive Masiyiwa's Econet Wireless Court challenge exemplifies how governments have historically fought against empowering their citizens (Mpondi 2018). However, TelOne is the sole provider of fixed-line services, providing them a competitive advantage in Internet services.

Partnerships and collaboration

A partnership between Zimbabwe telco TelOne and satellite communication services provider Avanti Communications was formed to roll out satellite broadband, resulting in high-speed satellite broadband to the country's small and medium enterprises market segment (ITWeb 2016). In Chitungwiza, TelOne introduced the Blaze long term evolution (LTE) cellular service to continue providing dependable, quick connectivity in support of the government's initiative to develop smart cities and a digital economy (Valela & Chingeke 2022). The promise of billionaire-owned Starlink, which aims to provide satellite Internet, is a bright spot in Zimbabwe, despite conflicting reports that these are attempts to obtain lithium minerals.

Challenges and potential solutions

To close the digital divide between urban and rural areas, TelOne has connected the Internet to almost 500 schools in impoverished and rural communities (*The Sunday Mail* 2022). The data available are not very vocal enough to give a clear picture of digital inequality, but it does exist. In contrast to South Africa, most of Zimbabwe's rural areas are not electrified. This is the fundamental infrastructure upon which digital services rely. Individuals in rural areas who own telephones lack a reliable power source to charge their handsets when the battery runs out. This never-ending loop widens the disparity between those with access to services and those with limited services. The differential factor is electricity and data costs, which are extremely exorbitant for most people who survive below the poverty datum line.

The solutions proposed for South Africa and Botswana can be implemented here to alleviate the highlighted challenges. There have already been successful instances where service providers have partnered up to deliver services on a unified front, such as the provision of satellite broadband by TelOne and Avanti Communications, as well as the Blaze LTE cellular service offering by TelOne in Zimbabwe. These ventures require more partnerships targeted at sharing infrastructural cost burdens, skills sharing and the ability to further invest in hardware and software required to set up these services. There is a need to further educate the people on these technologies and how they can benefit the nation. Therefore, service providers, in conjunction with the government, could roll out awareness campaigns that seek to educate the people on these technologies and the effects of vandalism of the costly hardware.

Case of Namibia

Ownership

Namibia's state-owned MTC was founded in 1995 as a joint venture by two Swedish companies, Telia and Swedfund, and the Namibian government (via the Namibia Post and Telecom Holdings Limited (NPTH), which owned a 51% share) (MTC Company 2021).

> In 2004, Swedfund and Telia sold their 49% shareholding to NPTH. In 2006, Portugal Telecom acquired a 34% shareholding in MTC. Portugal Telecom (through its subsidiary Africatel) delivers fixed, mobile, multimedia, data and corporate solutions. (MTC Company 2021, p. 10)

Infrastructure services

In response to digital innovation and improving access, MTC's first strategy focused on increasing mobile services (the first wave of the information era). The company repositioned its strategy in response to increased demand for web and e-commerce services throughout the Internet era (second wave). The third wave, which began in 2006, welcomed smartphones, mobile applications and cloud services.

Mobile Telecommunications Company is expanding its radio access network infrastructure through Project Capacity 2022, which includes sector splitting, technology upgrades and spectrum refarming to meet customer demand and ensure high-quality voice and data services. Mobile Telecommunications Company expanded the project's scope to renovate an additional 197 stations in 2022 and 2023 to relieve network congestion (MTC's 2022 Integrated Annual Report 2022). Its network has close to 97% coverage of the country, with 86% of health facilities covered by mobile broadband. A total of 29% of base stations with a population coverage of 45% offer 4G/LTE, while selected urban areas have a 5G network.

Device access

As part of its corporate social responsibility programme, MTC has given 26 smartphones to 26 checkpoints maintained by the Namibian Police nationwide. The donation was intended to support the prompt reporting of careless driving and preventing road accidents and criminal activity (Corporate Communications Department 2017). In addition, members of the Namibian Cabinet and Presiding Officers of Parliament received iPad devices from MTC as per the government's agenda for developing ICT infrastructure (MTC 2014).

The isolated donations and low quantity of devices indicate the insignificance of role players in donating devices. Furthermore, they donate to individuals who can afford it, which is not an attempt to combat digital inequality.

Service monopoly

Like in the other case studies, monopoly existed but ended long back as digital transformation demanded more role players, and governments had to issue licences to private service providers.

Partnerships and collaboration

Huawei's LTE4T65 agreed to provide high-speed Internet connectivity and improve mobile broadband data service for clients. Furthermore, MTC, Namibia University of Science and Technology and HUAWEI entered into a trilateral collaboration agreement to enhance research, innovation, technology and entrepreneurial excellence, as well as globalisation (Corporate Affairs Department 2022). Namibia would be positioned as a fit nation powered by digitalisation by exploiting strategic alliances. Furthermore, MTC signed a memorandum of understanding (MOU) with the leadership of the Municipality of Swakopmund, committing both sides to work together to help the public sector by providing creative and digital solutions (Corporate Affairs Department 2021).

Challenges and potential solutions

> Despite a report from Namibia's regulator, the Communications Regulatory Authority of Namibia (CRAN), highlighting infrastructure sharing as a factor contributing to high data costs for consumers in the country, Mobile Telecommunications Company (MTC) announced that it [would] not share its infrastructure with other [industry] players. (Ranjan 2023, p. 1).

Namibia seems to have handled its service provision set-up better. Their policies crushed the monopoly of a government agency on backbone network provision, allowing for smoother digital transformation. However, the MTC does not buy into the view of sharing infrastructure with other players in a bid to lower the costs that citizens have to pay for services. To reduce the cost of services, ISPs and VANS providers might have to consider the same options given for South Africa as follows:

- Investing in renewed hardware (save up to 50%–70% on IT costs)
- Choose from hardware support options (and build a hybrid maintenance strategy)
- Opt for aftermarket support (and avoid recurring hardware refreshes)
- Streamline multiple vendor servicing contracts (to simplify IT operations)
- Partner with professional service providers (and skip the effort of building an in-house team).

The subsequent reduction in financial strain for the ISPs would benefit their customers, that is, the citizens of Namibia whom MTC has been mandated to service. With reduced operational costs, the ISPs could charge the customers less, improving access and bridging inequality.

In southern Africa, government-owned telecommunications companies, such as Telkom in South Africa, BTC in Botswana, TelOne in Zimbabwe and MTC in Namibia, play a significant role in the market because of their historical contributions and large subscriber bases.

On the other hand, private providers such as Vodacom, MTN and Econet have significantly influenced the southern African telecommunications market, introducing competitive dynamics and technological innovations. This has led to increased market liberalisation, neutralising the dominance of government-owned providers and leading to expanded consumer choice. For example, in South Africa, Vodacom and MTN, both majority-owned by international entities, have played a pivotal role in driving technological advancements and offering a wide range of services, shaping the industry's competitive landscape.

Impact of telecommunications on digital inequality

This analysis sheds light on the interplay between government-owned and private/international telecommunications providers, impacting the digital service sector in southern Africa. Telecommunication companies play a major role in influencing digital service provision in the respective countries. Firstly, the provision of digital infrastructure in the country is one of the key aspects that determines the digital access and provision of related services in different areas. Other companies, such as those in the banking sector, rely on national telecommunication companies to lay the infrastructure needed to provide their services. People in different parts of the country can only do online banking if the ICT infrastructure is laid out in their communities. Secondly, infrastructure determines access for most people in different parts of the country. Thirdly, if there is a service monopoly in telecommunication, the company may not focus on innovation as there is no competition. The company may focus on increasing its profits while neglecting quality service for all citizens. Monopoly is usually associated with high prices, which deter citizens from service, especially the marginalised communities. Telecommunication companies play a significant role in shaping the digital economy. Telecommunication companies' policies on ICT can positively or negatively impact digital inequality. These companies' policies that provide access to digital services to all, regardless of income or location, can help to reduce digital inequality. On the other hand, policies that restrict access to digital services to certain groups or areas can increase digital inequality.

Based on the four case studies presented, it is imperative that we provide digital service best practices for encompassing end-to-end experiences that benefit consumers and service providers.

Best practices for digital services

Several literature sources (Conard 2019; Manoharan, Melitski & Holzer 2023; Pazarbasioglu et al. 2020) have identified some best practices in digital service provision in line with the United Nations Development Programme's (UNDP's) 17 sustainable development goals (SDGs) because interest in digital innovation is expanding rapidly across all societal sectors. The success of most, if not all, SDGs hinges on the provision of digital services. Fundamental to the provision of digital services are strategies and approaches to deliver high-quality digital services to customers, communities and the country at large, ensuring data security and privacy and managing the competitive environment in the digital landscape. These strategies are referred to in this chapter as best practices. In many countries, the advantages of the digital transition are indisputable. Given that the supply of digital services directly affects digital transformation, service providers need to plan and deliberate when disbursing the services to minimise any potential adverse effects on quality. Best practices provide a benchmarking tool to evaluate performance and help businesses adjust to changing conditions. Provisioning services without benchmarking tools is like building a house without a level – you risk creating an unstable and unreliable foundation for your digital offerings. A lack of best practices potentially increases the disparity in digital inequality. This section offers a concise summary of the standard best practices that DSPs should adhere to when organising and evaluating their customer service level.

■ Accessibility and inclusivity

Few providers traditionally target underserved communities and those with disabilities. Binga District in Zimbabwe (Garaiza 2023), Shangombo District in Zambia (Kapungwe 2004) and Lusikisiki in the remote rural areas in the Eastern Cape province of South Africa (Lembani et al. 2020) are well known for being behind in digital service provisioning. Although the countries have become independent, their historical past still influences the extent of and access to their digital services infrastructure in the mentioned regions. Successful digital transformation requires accessibility and inclusivity to protect marginalised groups and prevent the widening of the digital divide.

It is beyond doubt that profit-driven DSPs will always target towns where people can afford such services. Therefore, to counter this practice, government policies must be developed to provide incentives for DSPs willing to invest in remote areas, including lowering the tax bracket for these companies. Of course, if the government decides to adopt these measures, implementation will require rigorous vetting, as corruption may favour companies owned by or related to politicians who control policy decisions and the awarding of tenders. This is precisely what countries like Zimbabwe are grappling with, leaving underserved communities starved of digital services. Thus, it is essential for all stakeholders to be involved and take ownership of the initiatives.

In furtherance of digital transformation, higher education institutions must be involved to train people on the use of digital services. The focus should not only be on DSPs, as we have heard of cases of state-of-the-art digital infrastructure lying idle and being targeted by vandals because no one is using it. Typical cases of battery theft are common (Maboko & Dewa 2022).

While drug abuse and poverty give rise to such actions, it all boils down to perennial inequalities. Educational programmes that inform communities about the importance of such infrastructure could help, and creating opportunities in these areas might encourage the residents more responsible.

Three key pillars of digital service encompass people, processes and technology. Digital literacy is increasingly necessary to be digitally ready and aware. This chapter asserts that by training people in underdeveloped areas, providing accelerated access and instituting incentives and policy frameworks, the digital divide can potentially be narrowed.

Reliable service availability

Customers expect undisrupted service delivery as they pay for the service. Interrupted services result in resentment and service delivery protests. Issues of MTN network coverage in places such as Butterworth and Lusikisiki in South Africa are a weekly experience, as well as Econet's poor coverage in the Kotwa district in Zimbabwe. Several DSPs are now integrating DevSecOps into the delivery of technology to communities. As a practice, DevSecOps automates all stages so that service disruptions are minimal. Digital service providers can also use logs to predict disruptions and proactively deploy support teams to resolve them. Indeed, the aforementioned practice works well in urban areas, but there are numerous problems in remote locations, some of which are outside the control of the digital service provider. As a best practice, DSPs should collaborate with the government and other stakeholders. Collaboration helps to reduce internal resistance to innovation. We take note of the Allandale residents' resistance to the mobile tower in the Free State, South Africa, as they felt they were not consulted (Dlamini 2020).

Data analytics and insights

As digital services best practices continue to evolve, data analytics and insights provide organisations with valuable information and intelligence that can improve their offerings and stay competitive. Analysing data gives DSPs a deeper insight into user needs, preferences and trends. These insights empower organisations to make informed decisions, optimise their services and tailor offerings to meet evolving customer expectations. Digital service providers can run roadshows to get user input, which assists them in getting user feedback and improving service usability. South Africa, Eswatini, Namibia and Botswana have a lot of potential, as evidenced by the general statistics for digital services and the current percentage of people who do not use the Internet, which is likely because of a lack of services. Additionally, data analytics makes it possible to pinpoint problems and areas that need work, promoting the ongoing improvement of digital services. In today's data-driven business environment, attaining operational excellence, innovation and sustained growth requires the integration of data analytics and insights into digital services best practices.

Innovation

Innovation in technology must be a continuous process for competitive advantage and giving the best to the customers (Forlano et al. 2011), or they will remain behind. Selecting a solution and revisiting it after a while is not feasible because of the speed at which things change. Because digital services are available through the Internet as the backbone, embracing change is an imperative best practice for digital services in southern Africa, as it enables organisations to adapt swiftly to evolving technological landscapes. In a region characterised by rapid advancements and unique challenges, a proactive approach to change fosters innovation and ensures digital services remain relevant. While the region still has challenges in digital service provision, the Fintech industry has seen tremendous advancements, allowing people to do most of their banking. Customers can do most of their banking online, including sending and receiving money. Common platforms include Econet in Zimbabwe, MPesa in Kenya and SimbaPay in Burundi.

In comparison to European countries, an observation where they have improved is their banking services, where everything from opening bank accounts to paying bills is performed online. In southern Africa, this could further widen the gap because of the digital literacy gap and poor infrastructure. Internet network evolution is continuing rapidly, as shown in Table 10.3. Any digital service provider that does not keep up with this pace of innovation will continue to try to provide services that are no longer in demand.

TABLE 10.3: Evolution of mobile network technologies: Data rates, timelines and devices.

Category	Data rate	Timeline	Devices
1G (Analog Cellular)	2.4 Kbps	1980s	Landline phones and personal computer modems
2G (Digital Cellular)	Up to 64 Kbps	1990s	Analog mobile phones
3G (Mobile Broadband)	Upto 2 Mbps	2000s	Digital mobile phones, short message service
4G (Mobile Broadband)	100 Mbps – 1 Gbps	Late 2000s–2010s	Smartphones and mobile data cards
5G (Next Generation Networks)	10 Gbps – 20 Gbps	Late 2010s–2020s	Smartphones, tablets and IoT devices
6G (Future Generation Networks)	1 Tbps (Theoretical)	2030s (Expected)	Smartphones, AR/VR devices and IoT-enabled smart cities

Source: Author's own work adapted from Kamruzzaman 2022, p. 5608.
Key: G, generation; Kbps, Kilobits per second; Mbps, Megabits per second; Gbps, Gigabits per second; Tbps, Terabits per second; IoT, Internet of Things; AR, augmented reality; VR, virtual reality.

By embracing change, DSPs can better cater to different populations' unique requirements, fostering inclusivity and accessibility. Additionally, an adaptive culture puts businesses in a position to take advantage of new technologies, like mobile platforms, to close the digital gap in underserved and rural areas. Ultimately, success in southern Africa's dynamic digital environment comes down to an organisation's capacity to accept and manage change, which keeps it flexible, responsive and competitive.

Sustainable practices

Greening is the current environmental buzzword. According to George, Merrill and Schillebeeckx (2021), digital sustainability is defined as activities that seek to advance long-term SDGs through the creative application of technologies that generate, use, transmit or source electronic data. In the aftermath of the climate challenge, DSPs must include practical measures to address grand challenges to combat climate change and promote sustainable development (George et al. 2021). Digital service providers must aim to reduce energy consumption and environmental impacts by implementing sustainable practices. Digital service providers can collaborate with non-governmental organisations to source infrastructure that is about to be discarded or refurbished and donate it to poor economies. Such practices help close the digital divide because the infrastructure can train students in schools. However, the practice must be carefully reconsidered because it fosters a dependency culture in which citizens seek to receive instead of innovative ways to reduce inequality.

Independent regulatory bodies

Independent regulatory bodies serve several critical functions, including ensuring fair competition, protecting consumers, and promoting the responsible and ethical operation of the digital services sector. Examples of such bodies are the Independent Communications Authority of South Africa (ICASA) in South Africa, the Postal and Telecommunications Regulatory Authority of Zimbabwe (POTRAZ) in Zimbabwe, the Zambia Information and Communications Technology Authority (ZICTA) in Zambia and many others. Independent regulatory bodies help ensure the following:

- Fair competition
- Compliance with government regulations
- Conflict resolution: A good example was the case of Econet and the government

- Frequency spectrum and other resource allocation
- Consumer protection.

While these bodies are supposed to be independent, they are controlled by the government, which in itself is a digital service provider or controls a large share of countries top digital service companies such as TelOne in Zimbabwe, Telkom in South Africa and BTC. Independent regulatory bodies are critical for creating an environment that allows DSPs to thrive while protecting the interests of consumers, competitors and society.

Infrastructure sharing

As regulation expands beyond access alone and operators begin to differentiate themselves more by the services they provide, and as avoiding duplicating costly broadband services in poorer nations becomes a critical objective, legal and regulatory limits on sharing must be eliminated. Sharing base stations, routers and other network infrastructure is common in developed nations, and these nations have seen improved access (Gillwald 2017). An example is the Lebara network in the United Kingdom, which rides on the Vodafone platform.

Conclusion

This chapter aimed to evaluate the role of DSPs in alleviating inequality in southern Africa. When we started, we identified different types of DSPs (see Table 10.2). We then restricted the chapter to focus on government telecommunications companies or those with the government as the largest shareholder. In some literature, these are referred to as parastatals, but we avoided such terms to avoid negative connotations, as the term is associated with inefficiency, bureaucracy and lack of innovation.

We reviewed the literature on digital inequality, which sets the platform for the role of DSPs. Digital inequality is a pressing global issue that significantly impacts societal development and access to opportunities. Understanding the role of DSPs, particularly government telecommunications companies, is crucial in addressing and mitigating these disparities. Our definition of stakeholders and DSPs framed our area of focus. The adopted methodology of the case study gave this chapter a comprehensive and nuanced understanding of the role of government telecommunications corporations in tackling digital inequality in southern Africa. By evaluating various situations such as partnerships, collaboration, training to reduce digital illiteracy and the provision of digital devices and infrastructure as the foci of government telecommunications companies, the case study methodology identified effective strategies, potential dangers and critical elements for promoting digital inclusion. Government telecommunications companies must spearhead the drive to reduce digital inequality. In the current digital era, economies with a solid digital base have the potential to thrive economically and socially (Dahlman, Mealy & Wermelinger 2016).

In all four case studies, we can conclude that the different providers have significantly improved digital spaces. Unfortunately, technology is always evolving to the extent that while the providers are bust rolling out an innovation, a new one is already out in the market. Consequently, some areas are constantly left behind not by choice, but the rollout is overtaken by innovation, resulting in a widening digital divide. People in these locations are constantly subjected to digital inequality, which will continue for many years. Perhaps what is required is a shift in the sequence in which innovation begins. This chapter suggests that innovation should begin on the geographical outskirts of digital innovation. Given the related low returns in such regions, there is certain to be some reluctance from DSPs, particularly private subcontracted ones with a profit-driven focus. While theoretical exposition might be very informative, the utility of a chapter is determined by its practical application. Therefore, we suggested some best practices that governments should consider in the drive to address digital inequality through government telecommunication companies. Finally, we propose guiding questions within the chapter that governments should examine when considering whether to implement innovation with equality in mind:

- Which areas are way behind in terms of digital services?
- What needs to be done to make sure that the gap between those who are, in most cases, privileged to have the innovation against those who have been predominantly left behind?
- What should we value: Improved socio-economic status of a nation or just organisational profits?

Further studies should focus on independent DSPs and how the digital frameworks should be crafted for the sustainability of communities and nations at large.

The findings can help policymakers, telecom executives and other stakeholders create and implement more fair digital access strategies to eliminate digital inequality. Notably, government practice can sometimes be stifling when acting as a player and referee in digital domains. These data provide insights into the state of digital services in southern Africa. While the data demonstrate some inequalities in different countries, the data show that southern African countries are progressing well in digital service provision as supported by telecommunication companies and the respective governments, with countries like South Africa performing exceptionally well. It is noted that major improvements are lagging in remote communities, and this information provides practical leads in areas that still require attention.

The role of DSPs in alleviating inequality in southern Africa is significant, given the impact of the digital divide on the region's socio-economic disparities. Digital inequality is evident in access, digital literacy and Internet affordability, all contributing to widening the existing education, income and locational inequalities.

Providing digital services requires the commitment of all stakeholders, including government telecommunications companies and private companies. Future studies need to focus on the collaborative effort among these stakeholders. A future study can also assess the status of digital inequality and identify areas that require attention by monitoring and evaluating DSPs.

As we conclude Chapter 10 on the role of service providers in shaping and advancing digital services in southern Africa, we transition to a critical and related issue in the next chapter. Chapter 11 delves into the experiences of students with disabilities using assistive technologies in teaching and learning within southern African higher education institutions. This scoping review will provide valuable insights into the challenges and successes faced by these students, highlighting the importance of inclusive digital service provision and the role of assistive technologies in enhancing educational outcomes.

Chapter 11

Disabled students' experiences of using assistive technologies in southern African universities

Sandra Makwembere
Department of Human Resources Management,
Faculty of Management and Public Administration Sciences,
Walter Sisulu University,
Butterworth, South Africa

Obrain T Murire
Department of Networking and Information Technology Support,
Faculty of Engineering, Built Environment and Information Technology,
Walter Sisulu University,
Buffalo City, South Africa

Abstract

Students with disabilities often encounter several challenges related to digital inclusion, including inadequate access to assistive technologies, high costs of these technologies, inaccessible educational content and a lack of personalised learning. These barriers contribute to the digital divide by limiting educational opportunities and outcomes for students with disabilities. Assistive technologies are essential for enhancing digital inclusion, ensuring that digital advancements benefit everyone, regardless of physical or cognitive abilities, and promoting positive educational

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outcomes for students with disabilities in higher education. Consequently, exploring access to and the use of assistive technologies in educational settings is crucial. This chapter presents a scoping review of students with disabilities' experiences using assistive technology in selected southern African universities. It highlights how assistive technologies facilitate digital inclusion by equipping students with disabilities with the tools needed to access educational resources and fully participate in academic life. A systematic search of articles related to assistive technologies and their use by university students with disabilities was conducted, guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews. Searches of electronically available articles were performed using the Education Resources Information Centre, Scopus and Web of Science. English peer-reviewed publications from 2016 to 2023 were included, with 2016 serving as the starting year for identifying experiences within the context of the 2030 Agenda for Sustainable Development. A thematic synthesis was conducted on eight articles to develop key themes. The review highlighted both positive and negative experiences with assistive technologies and illuminated progress towards quality education through the recorded experiences of students with disabilities in university settings in the region. Recommendations for future research are provided in light of the findings.

Introduction

The last ten chapters have outlined the digital divide in South Africa from the perspectives of various sectors and stakeholders. This chapter concludes the book by outlining an example of an initiative to enable those who are always excluded to be included. The chapter provides examples of how those with disabilities could be considered to benefit from digital solutions. Additionally, the chapter highlights key factors and offers a situational analysis of the current landscape.

As we advance into the Fourth Industrial Revolution, the vital role of technology in modern society is becoming increasingly evident. However, the digital divide, especially in Africa, is a significant barrier to achieving the sustainable development goals (SDGs). This divide restricts access to essential digital services and skills needed by communities, exacerbating socio-economic and infrastructural disparities highlighted during the coronavirus disease of 2019 (COVID-19) pandemic. Furthermore, for various sectors namely, agriculture, health and education, digital inequality presents several unique challenges. For many African countries, agriculture is central to economic development. However, digital inequality has limited farmers' access to digital tools, thus affecting productivity levels and sustainability outcomes (refer to Chapter 6). Despite seeming improvements in information and communication technology (ICT) penetration in the sector, significant barriers such as affordability, lack of training and infrastructural weaknesses remain. In health, emerging technologies such as artificial intelligence (AI) and telemedicine offer promising solutions to digital inequality. Yet, in rural areas, there are challenges with integrating digital health technologies because of inadequate infrastructure and limited digital literacy among health care providers, resulting in poor health care delivery (Oki & Lukose 2024, see Chapter 7). Similarly, in the education sector, disparities in digital literacy and limited access to technology affect education service delivery and the subsequent attainment of learning outcomes for students from disadvantaged backgrounds. These students often lack the necessary resources and skills to fully benefit from digital learning environments, perpetuating cycles of educational inequalities.

As countries move towards Agenda 2023 and the African Agenda 2063, it is imperative to expose present digital inequalities and take concerted action to address these. Multifaceted approaches that consider the socio-economic, cultural and historical contexts of communities are required. Moreover, the implementation of digital solutions should holistically consider their sustainability, ethical implications, scalability, adaptability to local contexts and involvement of all key stakeholders. Within this context, assistive technology is a critical component of digital inclusion, especially for students with disabilities.

This chapter delves into the unique challenges and experiences encountered by students with disabilities in their quest to access and use assistive technologies in higher education. Building on the book's previous discussions about the impacts of the digital divide and digital inequality, attention is now paid to the specific barriers and opportunities relating to assistive technologies. Despite the acknowledged importance of assistive technology, there remain gaps in the literature on systematic examination of the experiences of students with disabilities using these technologies for learning in higher education settings in southern Africa. It is important that these experiences are understood to develop effective policies and practices that promote digital inclusion and support the educational success of all students. By presenting the intersection of disability, higher education and assistive technology in southern Africa, the chapter highlights the critical role that assistive technologies in higher education can play as sustainable solutions to real-world digital inclusion problems.

Education systems should be governed to enable countries to achieve the 17 SDGs. The alignment ensures that educational policies and practices contribute to sustainable development by promoting digital inclusion and equipping individuals with skills necessary for the digital age. With reference to SDG 4, which aims to achieve quality education, education systems across the globe are presently incorporating technologies in various ways to enhance the quality of education. Sustainable development goal 4 seeks to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'. There are ten targets accompanied by 11 indicators designed to measure the progress towards achieving them. These targets seek to achieve: free primary and secondary education; equal access to quality pre-primary education; affordable technical, vocational and higher education; increased number of people with relevant skills for financial success; elimination of all discrimination in education; universal literacy and numeracy; education for sustainable development and global citizenship; the building and upgrading of education facilities that are child, disability and gender-sensitive and provide safe, non-violent, inclusive and effective learning environments for all; increased numbers of scholarships available to developing countries and an increased supply of qualified teachers (United Nations 2015). Technologies such as educational technologies, ICTs, digital technologies, AI technologies and assistive technologies are being used to achieve these. The successful integration of various technologies to support a range of educational processes has opened up new avenues to education.

For people with disabilities, technologies can play a critical role in ensuring that people with disabilities have access to quality education in a range of ways, as how disability may manifest varies. Disability can be described as long-term physical, mental, intellectual or sensory impairments that, when interacting with various barriers, may prevent individuals from fully and effectively participating in society on an equal footing with others (United Nations 2006). Participation in society can be facilitated by the use of technology to support and empower people with disabilities. The United Nations Convention on the Rights of People with Disabilities (UNCRPD) recognises the important role that ICTs play in enabling and empowering people with disabilities and encourages countries to take opportunities to use them to support the socio-economic development as well as full, effective and equal participation of people with disabilities in society (United Nations 2006).

The use of assistive technologies has a range of benefits, such as improved academic performance, meaningful participation in social and educational activities, enhanced self-efficacy and greater self-esteem. Assistive technologies refer to different devices which assist persons with disabilities and special or rehabilitation needs to better function on a day-to-day basis and achieve a higher quality of life (Lancioni et al. 2013). In higher education, the literature reveals that the implementation of assistive technologies accompanies academic as well as psychosocial outcomes.

In relation to SDG 4, higher education is an important component of SDG 4; therefore, understanding what is achieved with assistive technologies is important. Higher education systems of countries vary; therefore, the ways that inclusive and equitable quality education is guaranteed and lifelong learning opportunities are promoted will differ. Higher education institutions can steer towards or away from SDG 4, for example, through the manner in which curriculum development, research, community engagement activities and teaching and learning activities are handled.

In southern Africa, the performance of countries in relation to SDG 4 has been multifaceted and complex because of diverse socio-economic conditions, varying levels of technological infrastructure and distinct educational policies. There has been progress and challenges (United Nations 2023). As far as technology is concerned, various policies and legislation have been integral to shaping the education landscape. The Southern African Development Community (SADC) has implemented policies and frameworks that recommend the use of technologies at all levels of education. For example, the SADC Digital Transformation Strategy encourages a commitment to digital transformation in education. Seemingly, it is well understood in the region that leveraging technologies in the education sector can yield numerous benefits. As country contexts differ, it is important that more research is undertaken to understand what is experienced in technology use to address any shortcomings. Equal, equitable and inclusive education cannot be achieved for people with disabilities apart from such assessments as capturing these experiences can highlight persisting inequalities and the impact of technologies on achieving SDG 4.

This chapter is a scoping review of students with disabilities' experiences of using assistive technologies in learning in southern African higher education institutions. The primary question this study sought to address is 'What have students with disabilities experienced in using assistive technology in learning at higher education institutions in selected southern African countries?' It provides a rapid review of the range and nature of research activity, summarises and disseminates research findings, and gives evidence to suggest the feasibility or relevance of a full systematic review (Arksey & O'Malley 2005). Disability is an important matter in developing the higher education sector because of its implications for inclusion, diversity, equity, educational outcomes, economic contributions and social development. Addressing disability in higher education requires creating environments that support and empower all students, including those with disabilities, to achieve their full potential. Thus, the review contributes insights into the role assistive technologies play in the educational experiences of some students with disabilities.

Focusing on selected countries, it presents these experiences in the context of achieving SDG 4. Insights are provided on the effectiveness of assistive technologies to enable and empower students with disabilities to fully participate in higher education as well as to promote inclusive and equitable quality education for all. There are very limited reviews that capture what students with disabilities experience in using assistive technologies in higher education from a regional perspective. As such, this scoping review aims to fill this gap by providing an overview of students with disabilities' experiences using assistive technologies for learning in higher education institutions in selected southern African countries. By systematically synthesising the existing research, the review seeks to highlight both the negative and positive experiences of these students, thereby offering insights into the current state of digital inclusion for students with disabilities and how assistive technologies can be leveraged to promote inclusive and equitable quality education as envisioned by SDG 4.

The following is a summary of the SDG performance of southern African countries, followed by a discussion of assistive technology and disability. Next, the methodology used for the study is presented. The experiences of students with disabilities regarding assistive technologies in higher education institutions are then examined. The chapter concludes with recommendations for the use of assistive technologies in learning at higher education institutions to improve the quality of education in southern Africa.

Sustainable development goal performance in southern Africa

The SDGs were introduced in 2015 as part of the 2030 Agenda for Sustainable Development which was adopted by all United Nations member states (United Nations 2015). They are a common blueprint to guide global efforts for a better present and future. The 17 SDGs are meant to address the world's most pressing challenges to development through addressing a range of interconnected matters such as education, health and climate change. They are meant to shape government priorities, policies and financial decision-making in different sectors, and progress in the country has been tracked over the years. The SDG index is the main tool presently used to assess the progress of countries towards attaining the SDGs. The score is presented on a scale of 0–100. This means that 100 is the target, while zero represents the worst possible state. The index covers all 17 goals and 169 targets and is based on the indicators that measure progress towards reaching the goals. The SDG index ranking is produced as well. The ranking represents where the Index score positions a country in relation to the other United Nations (UN) member states. The results of the assessments help countries identify areas where more effort is needed and recognise achievements.

Southern Africa's social and economic development is broadly characterised by a mix of challenges and opportunities (United Nations Development Programme et al. 2024). Similarly, the region's SDG performance has examples of some countries performing fairly well while others are performing poorly. The same can be said about the performance towards achieving SDG 4, which aims for inclusive and equitable quality education. Some countries have made good strides towards attaining the goal, while the performance of other countries has been poor. The level of standards in education achieved has implications for the resources, infrastructure and digital literacy needed for effective digital inclusion (Adeyemi & Oni 2021; Yingi, Hlungwani & Nyagadza 2022).

Table 11.1 provides a summary of the SDG index score for southern African countries from 2016 to 2022. It also includes the assessments made in the 2023 SDG report on the trends of these countries towards reaching SDG 4 (United Nations 2023).

Overall, the majority of countries in southern Africa have not shown significant progress towards achieving SDG 4.

Assistive technology and quality education

Assistive technologies are assistive, adaptive and rehabilitative devices for people with varying degrees of disability that are aimed at helping or expanding human function or capabilities (Maor, Currie & Drewry 2016). They are tools or systems that assist and support people who have disabilities, limited mobility or other limitations in doing tasks that would otherwise be difficult or impossible to do (Biegun et al. 2020; Kundu, Bej & Dey 2020). They can also be viewed as all services and systems associated with providing services and using assistive goods (WHO 2001). They can enhance or maintain the everyday quality of life by alleviating or compensating for an injury or impairment. Consequently, assistive technologies range from complex computerised communication systems and software applications to simple phone handles.

In higher education settings, assistive technology can help students with disabilities access learning. They are computerised and non-computerised technologies and services that increase, maintain or improve their capacities (Lamond & Cunningham 2020). There are text-to-speech systems that convert written text to voice, visual organisers to help students arrange their writing and voice recognition programmes that transform words spoken by students to text on a screen are all examples

TABLE 11.1: Sustainable development goal index scores and sustainable development goal 4 progress.

	SDG index scores							
SADC countries	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Assessment on progress towards SDG 4**
Angola	52.15	52.05	50.94	50.72	50.77	50.98	50.82	Major challenges remain Score moderately improving, insufficient to attain goal
Botswana	60.35	60.94	61.02	61.7	62.18	62.40	62.74	Significant challenges remain Trend information unavailable
Comoros	50.35	51.54	52.19	52.36	52.61	52.42	51.73	Major challenges remain Trend information unavailable
Eswatini	54.48	55.92	56.40	56.93	57.26	57.46	57.85	Significant challenges remain On track or maintaining SDG achievement
Lesotho	52.29	54.50	54.55	54.46	54.08	54.52	54.87	Major challenges remain Score stagnating or increasing at less than 50% of required rate
Madagascar	48.78	49.29	49.90	49.86	50.01	50.46	50.25	Major challenges remain Score decreasing
Malawi	52.76	53.17	52.99	55.38	55.44	55.92	56.30	Major challenges remain Score stagnating or increasing at less than 50% of required rate
Mauritius	66.71	67.83	67.96	68.56	68.91	68.82	67.98	Significant challenges remain Score stagnating or increasing at less than 50% of required rate
Mozambique	51.28	51.03	51.65	52.69	52.76	52.83	52.69	Major challenges remain Score moderately improving, insufficient to attain goal
Namibia	63.25	63.59	63.99	63.54	63.63	64.28	64.28	Challenges remain Score moderately improving, insufficient to attain goal
South Africa	62.19	63	62.46	63.24	63.75	63.95	64	Significant challenges remain Score decreasing
Zambia	52.21	52.53	53.43	53.38	53.55	53.24	54.28	Significant challenges remain Trend information unavailable
Zimbabwe	56.06	56.43	55.93	53.73	54.30	54.78	55.60	Major challenges remain Score stagnating or increasing at less than 50% of required rate

Source: Adapted from SDG Report 2023.
Key: SDG, sustainable development goal; SADC, Southern African Development Community.

of computerised assistive technology (Lamond & Cunningham 2020). They are designed to be specifically or widely available to avoid, compensate for, alleviate, or negate impairments and disabilities, increasing an individual's autonomy and quality of life (Lersilp, Putthinoi & Lersilp 2018). Assistive technology can contribute to the nature of education people with special educational needs and/or disabilities access, enhancing or maintaining their daily quality of life. In this chapter, a broad definition of assistive technology is adopted, encapsulating any technological tool that enables persons with disabilities to learn and engage in activities in a way that those without disabilities do.

Quality education is a multidimensional, dynamic and evolving concept that encompasses several aspects, including physical, moral and intellectual education (Shen & Wang 2021). A crucial dimension of quality education is digital inclusion, as it ensures that all students have access to educational opportunities by providing appropriate digital tools, adequate resources and supportive learning environments. Quality education encompasses a range of factors pivotal to providing students with disabilities with equal access to educational opportunities. Careful planning and support are needed for the successful integration of assistive technologies in educational opportunities. Various measures have been created to gauge the effectiveness of assistive technology choices. For example, the Quality Indicators for Assistive Technology (QIAT) Consortium has developed a set of eight indicators designed to guide the development and implementation of quality assistive technology services within educational environments. They are consideration of assistive technology needs, assessment of assistive technology needs, assistive technology in the individualised education programme, assistive technology implementation, evaluation of the effectiveness of assistive technology, assistive technology in transition, administrative support and assistive technology professional development (Quality Indicators for Assistive Technology Services 2024). Each indicator has accompanying matrices. These indicators and matrices help with the continuous improvement of assistive technology services as they cover various aspects to ensure that students with disabilities receive effective support.

Assistive technology can enhance a student with disabilities' capacity for self-determination, making engaging more in play, movement, communication and interaction across various settings easier. It can boost a learner's capacity for learning, level of independence and sense of self-worth. It empowers them to exhibit agency, express their needs and exercise self-determination. It facilitates participation in activities that enrich their lives and allows them to express facets of their personalities that would otherwise be hidden. Therefore, assistive technology is critical in promoting inclusive education and closing the achievement gap between students in educational settings. Assistive technology is especially important to help some students with disabilities become more independent, improve their communication skills and achieve better academically.

Assistive technology may tactically help children learn without compromising their independence (Biegun et al. 2020). It is evident how powerful independence for pupils can be when they use assistive technology. Students become more independent in their learning environments and their daily lives, as they have access to the right educational resources (Chambers et al. 2021). For students with special needs to reach their full potential, it is crucial that they have access to the right resources. This will guarantee their happiness and safety in a learning atmosphere (Lamond & Cunningham 2020).

Students may benefit from enhanced communication as a result of advancements in assistive technology (Biegun et al. 2020). A few examples include keyboard modifications and speech recognition software. Students may more readily express themselves through writing when they use these techniques. Moreover, they may be utilised to facilitate everyday activities and assist with improving their reading, writing, spelling and math skills (Chambers et al. 2021). Overall communication with others may become more effective with access to assistive technology (Johansson, Gulliksen & Gustavsson 2021). For example, a nonverbal student could converse with others using different communication technologies as communication resources they would not have with assistive technology become available (Biegun et al. 2020; Chambers et al. 2021).

During the education process, the needs of a person with a disability may vary; thus, the nature of support that might be needed can differ. Assistive technology can provide students with disabilities with the same educational opportunities as students without disabilities. However, context plays a role in how these opportunities are accessed. Challenges can exist, such as limited access to assistive technology, lack of training on assistive technology and lack of educator training on how to consider assistive technology use in teaching and learning. To achieve their academic objectives, students with disabilities need to have access to assistive technology, which may significantly help them become more focused and organised. With the same educational resources as their peers, students with assistive technology build confidence and self-worth, fostering peer connections (Johansson et al. 2021).

Research indicates that the utilisation of assistive technology by students with writing impairments enhances their note-taking abilities (Biegun et al. 2020; Chambers et al. 2021; Johansson et al. 2021; Tony 2019). The independence to do class work is enhanced. Better overall academic performance, including test scores and marks on assignments, would reflect these outcomes. By removing obstacles to education, assistive technology can give students with disabilities the tools they need to succeed in the classroom (Lersilp et al. 2018).

For example, text-to-speech software can increase dyslexic pupils' understanding, which will help them read better (Tony 2019). A visually impaired student may benefit from using a Braille keyboard to enhance their learning process. This can improve overall grades (Kundu et al. 2020). Assistive technology may be quite beneficial for students with disabilities. It allows people to participate more fully in intellectual and social environments and reach their full potential.

While there is research interest in assistive technology, more needs to be understood about what users of assistive technology experience to ascertain the realities of assistive technologies at different levels of education. What follows is the methodology for this chapter's study.

Methodology

An adapted version of Arksey and O'Malley's (2005) scoping review framework was used to guide the scoping study. The stages followed involved identifying the research question, identifying relevant studies, selecting the studies, charting the data and finally, collating, summarising and reporting the results (Arksey & O'Malley 2005). A review protocol was developed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis extension for scoping reviews (PRISMA-ScR) (Tricco et al. 2018).

Eligibility criteria

Specific characteristics were used as eligibility criteria. These were country, methodology, conceptualisation of disability, conceptualisation of assistive technology and student experiences of assistive technology use. Boolean search strings were created by combining keywords, phrases and terms related to assistive technology, disabilities and higher education. The search strings incorporated Boolean operators (AND, OR) to ensure a thorough and precise search. The search strings were adapted and applied to three databases: Education Resources Information Centre (ERIC), Scopus and Web of Science. Table 11.2 provides the search strings used for the different databases and the number of hits these generated.

Inclusion criteria

Peer-reviewed articles were included, while all non-peer-reviewed articles were excluded. Articles published in English between 2016 and 2023 based on primary data were included. The period of focus was 2016–2023. Besides, 2016 was selected as a starting point because this is the year the implementation of SDGs began. What was examined was the country

TABLE 11.2: Review search strings.

No.	Search string	Database and number of hits
1	('assistive technology' OR 'assistive technologies') AND ('students with disabilities' OR 'SWDs' OR 'SWD' OR 'disabled') AND ('higher education' OR 'post-secondary education' OR 'higher learning') AND ('Angola' OR 'Botswana' OR 'Comoros' OR 'Eswatini' OR 'Swaziland' OR 'Lesotho' OR 'Madagascar' OR 'Malawi' OR 'Mauritius' OR 'Mozambique' OR 'Namibia' OR 'South Africa' OR 'Zambia' OR 'Zimbabwe')	ERIC: 10 Scopus: 118 (limited to article, limited to English) Web of Science:2
2	('assistive technology' OR 'assistive technologies') AND ('students with disabilities' OR 'SWDs' OR 'SWD' OR 'disabled') AND ('higher education' OR 'post-secondary education' OR 'higher learning' OR 'university' OR 'universities') AND ('Angola' OR 'Botswana' OR 'Comoros' OR 'Eswatini' OR 'Swaziland' OR 'Lesotho' OR 'Madagascar' OR 'Malawi' OR 'Mauritius' OR 'Mozambique' OR 'Namibia' OR 'South Africa' OR 'Zambia' OR 'Zimbabwe')	ERIC: 10 Scopus: 346 Web of Science: 6
3	('assistive technology' OR 'assistive technologies') AND ('with disabilities' OR 'disabled') AND ('higher education' OR 'university' OR 'universities') AND ('Angola' OR 'Botswana' OR 'Comoros' OR 'Eswatini' OR 'Swaziland' OR 'Lesotho' OR 'Madagascar' OR 'Malawi' OR 'Mauritius' OR 'Mozambique' OR 'Namibia' OR 'South Africa' OR 'Zambia' OR 'Zimbabwe')	ERIC: 11 Scopus: 476 Web of Science: 12

Source: Authors' own work.
Key: ERIC, Education Resources Information Centre.

context, the methodology used in the research approach, the data collection method and participants reached, the definition or conceptualisation of disability, the definition or conceptualisation of assistive technology and student experiences of using assistive technology. These different aspects were used as an analytical framework for the information on the recorded experiences and their sources. A summary of the criteria is summarised in Table 11.3.

Study selection process

A total of 991 studies were identified through database searches. Eight hundred (800) duplicates were identified and removed, leaving 191 records. The abstracts and titles of the remaining 191 were screened. The reasons for the exclusions included not including any southern African country, focusing on school learners, not focusing on university context and being based on secondary data. Thirty-seven articles remained for full screening. These were assessed for eligibility, resulting in the exclusion of 29 articles. Finally, eight articles met all criteria and were included in the qualitative synthesis. Figure 11.1 illustrates the processes.

TABLE 11.3: Inclusion and exclusion criteria.

Criteria	Reason for criterion	Inclusion	Exclusion
Country focus	To provide a regional perspective and ensure understanding gained is related to southern African contexts	Studies conducted in southern African countries only or in comparison with countries in other regions	Studies conducted in countries outside southern Africa
Methodology	To ensure that insights into the use of assistive technologies are based on lived experiences and real-world data	Empirical studies using qualitative, quantitative or mixed-method approaches Data collected from the students with disabilities Study site a university	Non-empirical studies Views of student experiences not from students themselves Study site not a university
Conceptualisation of disability	To enable a nuanced understanding of how the impacts of assistive technology use may have been analysed	Conceptualisation or description of disability included and/or reference to disability is made	No reference to disability is made
Conceptualisation of assistive technology	To ensure that there is attention paid to assistive technologies rather than general educational tools	Conceptualisation or description of assistive technology included and/or reference to disability is made	No reference to assistive technology is made
Student experiences of using assistive technologies	To capture the direct experiences of students who use assistive technologies	Students views on assistive technologies	Student views not on assistive technologies Non-student views on assistive technologies
Publication dates	To situate the experiences within the SDG period	January 2016 to November 2023	Before January 2016
Language	Most accessible to researchers	English	Non-English

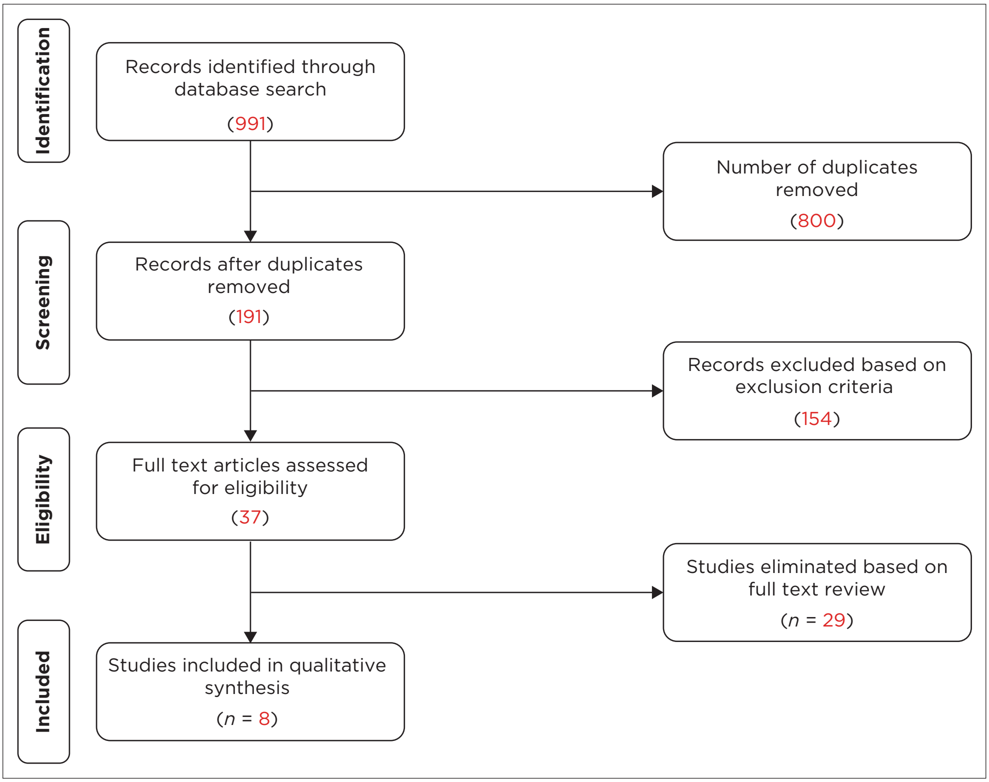
Source: Authors' own work.
Key: SDG, sustainable development goal.

Data extraction

Data were arranged using a predefined form to extract relevant information on country focus, methodology, conceptualisations of disability and assistive technology, and student experiences.

Findings

The use of assistive technologies in higher education is crucial to ensure that students with disabilities have equitable access to learning opportunities and achieve their academic potential. This section synthesises the findings from the reviewed studies.



Source: Authors' own work.

FIGURE 11.1: Preferred reporting items for systematic review and meta-analysis extension for scoping reviews flow diagram of the selection process.

Country focus

Countries have research ecosystems characterised by complex dynamics (Jaffe et al. 2020). The country's focus on publications indicates where insights into an issue have been gathered and, to an extent, where attention to an issue is being given. Of the eight articles, the majority focused on experiences in South Africa (five articles), with additional insights from Zambia (two articles) and Eswatini (one article). Mostly South African institutions were the subject of study, suggesting higher research activity and perhaps greater institutional emphasis on assistive technology.

Methodology

All the studies used qualitative research approaches. This methodological choice is especially effective for exploring nuanced and subjective aspects of using assistive technologies. Interviews and case studies captured the lived experiences of the students. The voices which made up the qualitative projects were important because the knowledge gathered about the particular objects of study relied on these (López-Deflory, Perron & Miró-Bonet 2022). The articles were all based on the expressed views of students with disabilities who use assistive technologies, thus providing in-depth insights into how students interact with assistive technologies and the challenges they face. A few studies also gathered information from other informants, such as disability unit staff.

Conceptualisation of disability

The conceptualisation of disability can influence the portrayal of students with disabilities and their educational experiences (Shume 2023). It varied across the selected studies. Four articles did not provide clear information about how disability was conceptualised, though examples of disabilities were provided. These arguably provided a more medical or functional definition by focusing on specific impairments and their impacts on learning. Four articles expressed a recognition of the role of the social context in disability experiences, with two explicitly indicating that a social model of disability was adopted. The social model of disability emphasises the role of the social environment in facilitating or hindering the participation of persons with disabilities (Shakespeare 2006). Disability was largely captured as an experience of interaction between impairments and social context in the studies.

Conceptualisation of assistive technology

Half the articles provided clear conceptualisations of assistive technologies. Broadly, assistive technologies definitions included high-tech and low-tech solutions to support students with disabilities. The descriptions of assistive technologies indicate the understanding of what needs they address. The descriptions largely captured assistive technologies as having a diverse range of options. For the studies that explicitly defined assistive technology, the descriptions recognised the interaction between the user, their environment and the device. Thus, the role assistive technologies play in enhancing the functional capabilities and independence of students with disabilities was provided. The articles that did not provide definitions or descriptions did identify examples of assistive products or devices used by students with disabilities.

Experiences of assistive technology use at university

The experiences of students with disabilities using assistive technologies in higher education were mixed, with both positive and challenging experiences reported.

Positive experiences

The positive experiences of using assistive technologies highlight these tools' pivotal role in promoting digital inclusion and equitable access to quality education. They draw attention to the importance of continued investment in and support for assistive technologies to create inclusive educational environments that cater to all students' diverse needs. The experiences are summarised in this section.

Increased access and participation

Students using assistive technologies report increased access to learning materials and enhanced participation in academic and social activities. These technologies are crucial in enabling them to engage with educational content that might otherwise be inaccessible. For instance, students with hearing impairments who use voice recorders find these tools instrumental in capturing and reviewing lectures, enhancing their ability to study effectively. One student at a South African university described their experience, stating:

> 'I am also partially deaf, and because of this, the Disability Unit gave me a voice recorder to use in my lectures. The thing was, I found it very useful because I did not have enough time to study and transcribe my lecture notes.' (Student 1 in Ndlovu 2021, p. 10)

Similarly, visually impaired students benefit from assistive technologies that facilitate communication and learning. A student at a university in Eswatini shared:

> 'I can receive and respond to WhatsApp messages because my cell phone has JAWS to help me with on-screen reading and typing back the feedback. This makes it easier to communicate with my lecturers as well, who sometimes send text messages or audio notes.' (Student in Ferreira-Meyers & Pitikoe 2021, p. 346)

Students with mobility impairment also express positive experiences with assistive technologies that help them navigate their physical environments and participate in daily activities. For example, a student using a wheelchair at a South African university mentioned:

> 'I do not see what I am missing out; the only times I get reminded of being in a wheelchair is when I see stairs and cannot go up these.' (Sipho in McIntrye et al. 2019, p. 76)

These testimonies highlight the vital role assistive tools play in improving academic outcomes, encouraging social participation and promoting digital inclusion in higher education settings.

Enhanced independence and motivation

Assistive technologies have played a vital role in promoting independence among students with disabilities. By reducing the need for constant assistance from family and peers, they foster a sense of self-reliance and confidence is fostered. For example, students with mobility impairments can participate in adaptative sports, such as wheelchair basketball, which boosts self-esteem and motivation. This increased motivation positively affects the overall university experience.

A student at a South African university using a wheelchair recognised that wheelchair basketball facilitated participation at the university and kept them motivated. They stated:

> 'Basketball is like a big part of my life. I love basketball… the main reason I am playing basketball is not because it is stressful. Like, I believe that when there is like so much to do academically, I need that break.' (Sipho in McIntyre et al. p. 75)

By supporting students' independence and motivation, these technologies contribute to their success (Lersilp et al. 2018).

Improved communication

Effective communication is vital for academic success, and assistive technologies have facilitated it for students with disabilities. The compatibility of Job Access With Speech (JAWS) software with communication platforms, such as WhatsApp and email, has enabled visually impaired students to maintain consistent and effective communication with their lecturers and peers. This has improved their access to academic support and resources as well as strengthened their social connections within the university.

A visually impaired student at a university in Eswatini who uses JAWS on their laptop and phone remarked on the benefits during the transition to remote learning because of COVID-19:

> 'The lecturer used different learning platforms to continue teaching and learning. For instance… Google Classroom makes learning much easier for me because all the updates immediately go to my Gmail account, and I can access the material… My tests were sent via an email and I…[could] submit via email.' (Student in Ferreira-Meyers & Pitikoe 2021, p. 348)

These experiences point to the role of assistive technologies in enhancing communication for visually impaired students, ensuring that they remain connected and engaged in educational pursuits even during challenging circumstances such as a global pandemic. By bridging communication gaps, these technologies promote digital inclusion by enabling students to participate more fully in their academic and social environments.

Challenges and negative experiences

Students with disabilities face several multifaceted challenges in using assistive technologies. Understanding them can assist in creating more supportive and equitable environments for students. A synthesis of challenges and negative experiences is summarised in this section.

Inadequate and inconsistent provision of assistive technologies

One of the most significant challenges faced by students with disabilities is the inadequate and inconsistent provision of assistive technologies by educational institutions. Often, there is a disconnect between what institutions believe to be adequate support and the actual needs of students. This gap leads to many students not having access to necessary devices such as Braille machines, scientific calculators or advanced software like JAWS. The insufficient provision of these technologies negatively affects students' ability to participate in learning fully.

For example, one student with a visual impairment at a university in Zambia reported:

> 'When I came here…I thought I would be provided with orientation and mobility support, by helping me with a white cane and then orient me on the infrastructure. Sadly, I was not oriented.' (Steel in Simui et al. 2019, p. 53)

Similarly, a student with a learning disability at a university in South Africa expressed:

> 'It would be nice if I had something to help me with reading. I tend to be very slow at it…but those things are very expensive, and some of the licenses need to be renewed now and then.' (Tess in Manase 2023, p. 10)

A student with a visual impairment at a university in Eswatini shared:

> [W]hen I finally enrolled at the university, I was determined to have my own laptop. When we went for these computer training sessions, I discovered that the machines did not have the JAWS software which I had thought the university would have thought about, and had it installed on at least one or two computers to accommodate us. I felt discriminated against. Then I bought my personal laptop and installed JAWS.' (student with visual impairment in Ferreira-Meyers & Pitikoe 2021, p. 347)

The experiences underscore the critical gap between institutional support and student needs. They highlight how the lack of adequate assistive technology provision can affect students' academic progress and participation and that there is a need to promote digital inclusion and equity by aligning support systems with the real needs of students.

Poor accessibility and accommodations

Accessibility issues are another major challenge and barrier to learning for students with disabilities. Many students experience inaccessible learning environments and learning materials which hinder their ability to excel in their academic pursuits. For instance, one student with a visual impairment at a South African university expressed frustration with inaccessible physical infrastructure:

> 'I remember one time; I bumped into a metal pole when I was surveying the university premises…Such an experience made me fear to move alone. I anticipated that there could be many other poles like that.' (Charm in Simui et al. 2019, p. 48)

Similarly, another student with a visual impairment at the same university shared the difficulties of navigating the campus layout:

> 'The place has TOO MANY STEPS! [Amplified voice]. Those steps become a hindrance to my mobility.' (Steel in Simui et al. 2019, p. 48)

These physical barriers create significant challenges for students who wish to navigate campuses independently and safely.

Many online learning platforms and educational materials are not designed with accessibility in mind. Consequently, students have a difficult time trying to engage with the content provided. Specific challenges include JAWS not reading mathematical signs or PowerPoint presentations, the lack of audio options for students with visual impairments and the lack of text captioning for students with hearing impairments.

One student with total visual loss at a South African university bemoaned the limitations of the assistive technology available to them:

> 'The computers we use have screen readers. They have JAWS, but they cannot read Mathematical signs and graphs. JAWS do not read pictures. Sometimes they teach in PowerPoint, but in my case, JAWS cannot read PowerPoint.' (Student 6 in Ndlovu 2021, p. 11)

These accounts underscore the need for educational institutions to address accessibility comprehensively so that the full benefits of using assistive technology are attained.

Furthermore, where reasonable accommodations involve assistive technology, institutions ought to be able to meet this need.

A student with quadriplegia at a South African university expressed:

> 'Whenever we ask to be reasonably accommodated, the invigilators say: Do you think you are special? Why do you have to always ask for special treatment? I tell them I am not special, but I have special needs that need to be accommodated for me to learn effectively. I think the invigilators have not been sensitised to

> the needs of students with disabilities.' (Female student with quadriplegia in Ngubane-Mokiwa & Zongozi 2021, p. 143)

Similarly, students with learning disabilities at a South African university shared their struggles with 'fast-paced' lectures and lecturers who 'rush information' (Manase 2023, pp. 7–8). The lack of accommodation means students sometimes cannot contribute meaningfully during lectures.

Lack of training and support to use assistive technologies

The lack of training and support for both students and university staff on how to effectively use assistive technologies is a major problem. Some students need additional training to navigate online platforms and use assistive devices proficiently. However, institutions often fail to provide this essential support. This means that students are left to struggle with the technologies on their own. This lack of training and support exacerbates students' difficulties, especially those new to using assistive technologies.

One student with paraplegia at a South African university relayed:

> 'There are some of us who recently became disabled, and we have no knowledge of assistive devices and how they can enable our access to education.' (Female student with paraplegia in Ngubane-Mokiwa & Zongozzi 2021, p. 144)

Another student at a South African university who had to train themselves to use speech-to-text on their laptop expressed mixed feelings about the experience:

> 'This was both frustrating and exciting because I was learning something new.' (Student with disabilities in Duma & Chamane 2023, p. 36)

Without sufficient training, the academic success and personal development of students with disabilities will be hindered.

Financial barriers

Financial constraints are another barrier. The high cost of assistive devices and software, coupled with limited funding provided by educational institutions, makes it difficult for students to secure the necessary tools for learning. Also, students often incur extra costs for Internet access and travel to public facilities where they can use specific software. The added financial burden complicates their ability to learn effectively.

One student with a disability at a South African university shared:

> 'The funding covers assistive devices, yes, but assistive devices are very expensive. When someone needs a scientific calculator, the Braille one is R4000-00. Braille machine is R4000-00. There was a time when I did not have a laptop. I went

> to the Disability Unit, and they told me to go to the Financial Aid office. I went there, but I did not get assistance.' (Student 2 in Ndlovu 2021, p. 10)

Another student with blindness at a South African university expressed:

> 'For some of us who became disabled during the course of the year, there are no assistive devices provided by NFSAS [National Student Financial Aid Scheme]. These tools are expensive! Leave alone the fact that we cannot even use them efficiently.' (Male student with blindness in Ngubane-Mokiwa & Zongozzi 2021, p. 144)

The same student, referring to work-integrated learning (WIL) programmes, which require students to gain experience at workplaces, pointed to the personal costs incurred in participating. They expressed:

> 'Work Integrated Learning (WIL) programmes require students to avail themselves at workplaces for practical experience ...students struggle to get to the company they are assigned to. We have to spend a lot of money to get accessible accommodation near the workplace.' (Male student with blindness in Ngubane-Mokiwa & Zongozzi 2021, p. 145)

The experiences above highlight the need for improved financial support and accessible resources for students with disabilities who use assistive technologies.

Other negative encounters

The emotional and psychological impact of insufficient support and negative attitudes towards disability cannot be overstated. Some students with disabilities face increased anxiety and emotional stress because of the lack of appropriate assistive technology and support (Manase 2023). Moreover, negative attitudes and lack of understanding from peers and lecturers contribute to feelings of humiliation and exclusion. This adversely affects the mental well-being and academic performance of students. Also, the stress of dealing with unsupportive educational environments can affect students' overall higher education experience.

Faced with insufficient institutional support, some students have developed self-devised coping strategies to manage their learning and emotional well-being (Manase 2023). These strategies include animal therapy, self-affirmation, family support and prayer. While these strategies demonstrate a level of resilience and agency among students, they also highlight the gaps in institutional support that need to be addressed. Students' reliance on their own personal coping strategies points to a lack of systemic solutions to adequately cater for the needs of students with disabilities.

Systemic challenges in higher education institutions include inadequate time allocations for online assessments and non-inclusive teaching practices.

These hinder the academic success of students with disabilities. The exclusion from Science, Technology, Engineering, and Mathematics fields is particularly pronounced where laboratories and workspaces are inaccessible (Ngubane-Mokiwa & Zongozzi 2021). This prevents students from fully engaging in these important areas of study. Similarly, WIL programmes are often not adapted to accommodate students with disabilities. This often leads to students carrying the additional financial and logistical burdens of participating (Ngubane-Mokiwa & Zongozzi 2021). The summary of key findings from data extracted from articles is presented in Table 11.4.

Attaining quality higher education through assistive technology

The findings in the previous section highlight the importance of assistive technology in achieving quality higher education in southern Africa. Access to assistive technologies is crucial for promoting inclusion and accessibility to students with disabilities as well as bridging the gap in educational opportunities. When effectively incorporated into teaching and learning environments, they can transform these settings into more conducive spaces for learning, enabling students with disabilities to thrive alongside their peers. While some students report positive experiences of assistive technology use at university, their negative experiences demand our attention and response to ensure truly inclusive education systems in the region.

One of the critical barriers to accessing assistive technology is societal perceptions of or incorrect beliefs about disability, which can reinforce or create obstacles for students (Boot, MacLachlan & Dinsmore 2019). Consequently, any efforts to improve the availability and use of assistive technologies must be situated within a dynamic context of shifting understandings and interactions with disability. Paying attention to the social construction of assistive technology is essential as the social context within which interactions occur significantly impacts how SDG4 is advanced (Steel 2022). In many cases, the interplay between the social construction of disability and assistive technology is intensified by existing social inequalities. Efforts to address assistive technology needs for students with disabilities must recognise the social dynamics associated with interventions. Southern African countries are characterised by significant inequalities, and interventions cannot ignore the implications of these disparities. Research has consistently shown that disability correlates with disadvantage (Hosseinpoor et al. 2013). For instance, a higher education institution's choice of assistive technology must consider accessibility and inequality. A device only available at the institution can lead to unequal

TABLE 11.4: Summary of key findings.

Article details	Country focus	Methodology	Disability conceptualisation	Assistive technology conceptualisation	Summary of experiences
[1] McIntyre, J., Gurayah, T., Adonis, N., Elliott, L. A., Müller-Nedebock, A., & Sibeko, Z. (2019). Exploring facilitators to participation for wheelchair users at a South African university. *Africa Education Review*, *16*(5), 70–85.	South Africa	Qualitative approach Exploratory single case study design Semi-structured interviews with one wheelchair user and two peers	'A complex interaction between a variety of factors, including impairment; the individual's aspirations; and contextual factors such as the environment and policies' (p. 71)	Detailed one not included Wheelchair indicated	Positive: Increased participation in academic and extracurricular activities Enhanced sense of independence and self-worth Boost in self-esteem and motivation More social interaction and support from peers Accessible infrastructure Challenges: Dependence on others for daily activities Insufficient support navigating university
[2] Simui, F., Kasonde-Ngandu, S., Cheyeka, A. M., & Makoe, M. (2019). Lived disablers to academic success of the visually impaired at the university of Zambia, sub-saharan Africa. *Journal of Student Affairs in Africa*, *7*(2), 41–56.	Zambia	Qualitative approach Hermeneutic phenomenology research design Six undergraduate students with visual impairments and one postgraduate student with visual impairment	Social model of disability understanding provided	Detailed one not included Examples of assistive learning devices include as eyeglasses, canes, computers, voice recorders, JAWS software, embossers, scanners and magnifying lenses	Positive: Technical skills gained Integration into academic and social life Challenges: Inadequate assistive learning devices at institutions contributed to - students relying on their own devices - non-conducive learning environment (e.g. where lecturers lack the capacity to integrate assistive learning devices in teaching and learning) - inadequate mobility and orientation services - neglected impairment and assistive device needs
[3] Simalalo, M., & Hambulo, F. (2019). The Learning Conditions Experienced by Students with Visual Impairments at the University of Zambia. *Journal of the International Association of Special Education*, *19*(1).	Zambia	Qualitative approach Case study design Interviews with 10 students with visual impairments, four lecturers, 2 faculty deans, two heads of departments, and two institution managers Observations	Detailed one not included. Types of disabilities noted visual impairment, low vision and blindness	'Devices or systems that improve or maintain Functional capabilities of students' (p. 11)	Challenges: Overall limited access to Assistive technology contributed to - limited participation in learning - barriers to navigating the physical environment - undermined the ability to learn - inability to study the programme of choice - limited access to services, for example, adapted learning resources

Table 11.4 continues on the next page→

TABLE 11.4 (cont.): Summary of key findings.

Article details	Country focus	Methodology	Disability conceptualisation	Assistive technology conceptualisation	Summary of experiences
[4] Ngubane-Mokiwa, S. A., & Zongozzi, J. N. (2021). Exclusion reloaded: The chronicles of COVID-19 on students with disabilities in a South African open distance learning context. *J. Intellect. Disabil. Diagn. Treat*, *9*, 137–147.	South Africa	Qualitative approach Interviews – 10 students from a larger study of 6000	Detailed one not included Types of disabilities noted, for example, quadriplegia, visual impairment, dyslexia, blindness, partial sight, paraplegia and mobility disability	Detailed one not included. Examples of ATs provided by student groups included Digital Accessible Information System, computers and crutches	Challenges: Lack of access to assistive technology, accompanied by: - inadequate training on the use of assistive technologies - inadequate digital skills to use assistive technologies - inability to access learning materials and platforms - absence of funding for assistive technologies - limited accommodations for assistive device use e.g. no extra time for the blind person listening to audio questions and typing using a device - inadequate hardware and software provision - inappropriate aesthetic design - inaccessible ICT platforms - file size limits for online document uploads
[5] Ferreira-Meyers, K., & Pitikoe, S. (2021). The learning experience of a visually impaired learner regarding emergency blended teaching and learning at a higher education institution. *Perspectives in Education*, *39*(1), 340–352.	Eswatini	Qualitative approach Narrative case study One student with visual impairment Semi-structured interview	Social model of disability Disability is a social construct that results from the 'interrelationships Between a dysfunction, an individual response to this dysfunction and the environment' (Sztobryn-Giercuszkiewicz, n.d:5) (p. 345)	'Any item, piece of equipment, or product system, whether acquired commercially off the shelf, Modified or customised, that is used to increase, maintain or improve functional capabilities of individuals with disabilities (as defined by the 2004 Individuals with Disabilities Education Improvement Act or IDEA promulgated in the USA)'. (p. 343)	Positive: - Easier communication with lecturers as was able to send and receive WhatsApp messages and text messages as well as listen to audio notes on phone with JAWS - Access to learning materials Challenges: - Phone incompatible with online teaching despite having JAWS on it - Use of personal resources for example to buy a personal laptop on which to install JAWS - Computer skills training which did not have computers with JAWS nor demonstrate how to use it - Computers without JAWS in computer labs - No centre at the institution to cater for the needs

Table 11.4 continues on the next page→

TABLE 11.4 (cont.): Summary of key findings.

Article details	Country focus	Methodology	Disability conceptualisation	Assistive technology conceptualisation	Summary of experiences
[6] Ndlovu, S. (2021). Provision of assistive technology for students with disabilities in South African higher education. *International Journal of Environmental Research and Public Health*, *18*(8), 3892.	South Africa	Qualitative Semi-structured interviews with six students with disabilities (one with total vision loss, one with partial vision loss, two with partial hearing loss and two with physical disabilities using wheelchair) and 10 staff from Disability Rights Centre (two with albinism and low vision, two with physical disabilities using wheelchair, six without disabilities)	Critical disability theoretical conceptualisation of disability as 'a form of diversity, and this extends beyond an outmoded understanding of disability as an identity for persons with impairments' affected by 'material and local contextual conditions' (p. 4) Intersectionality lens that 'disability should not always be seen in terms of disadvantage' (p. 4)	'Products with the primary purpose to sustain individuals' functioning and independence to promote their academic, social and physical wellbeing' (p. 1)	Positive - Assistive technology provided by institutions assisted with learning Challenges - Inadequate provision of assistive devices - Inadequate institutional funding provided for assistive devices - Limited functionality of assistive devices, for example, screen readers which cannot read PowerPoint and mathematical signs and graphs

Table 11.4 continues on the next page→

TABLE 11.4 (cont.): Summary of key findings.

Article details	Country focus	Methodology	Disability conceptualisation	Assistive technology conceptualisation	Summary of experiences
[7] Duma, T., & Chamane, L. L. (2023). Epistemic access for students using assistive technology in the introduction of online teaching. *Disability, CBR & Inclusive Development*, *34*(1), 27–45.	South Africa	Qualitative 25 students with disabilities (eight hearing impairment, 10 visual impairment, four spinal cord challenge, two hand deformity, one brain damage) Semi-structured interviews One focus group discussion with 13 students with disabilities	Detailed one not included Disability experiences from those identified as having a hearing impairment, partial visual impairment, artificial eye, blind eye, clinically blind, spinal cord nerve damage, paralysis, weak right hand, some missing fingers and partially brain damaged	Detailed one not included Assistive technologies listed included smartphones, laptops, hearing devices, glasses, phones with large tactile buttons, magnifiers, wheelchair hand support	Challenges - Long processes to receive disability funding for assistive technologies - Difficulties accessing and using assistive devices - Lack of appropriate assistive technology, for example, laptop without appropriate set-up for condition - Lack of accommodations outside the university which affected the ability to learn, for example, inaccessible transport vehicles and Internet cafés - Low technical skills - Pain and irritation when wearing hearing aids for extended periods - Limited space on cellphone - Use of personal finances for adaptations of materials, for example, typing services to turn audio into text - No challenges expressed by one student
[8] Manase, N. (2023). Self-devised assistive techniques by university students with learning disabilities. *African Journal of Disability*, *12*, 1106.	South Africa	Qualitative approach 15 students, eight lecturers, five staff from Disability Unit and Centre for Teaching and Learning Semi-structured interview	'Results from limited interaction between individuals with a health condition with personal and environmental **factors'** (p. 1)	'An umbrella term that includes assistive, adaptive and rehabilitative devices and services for persons with disabilities, which enable persons with disabilities and learning differences to attain independence' (p. 2)	Challenges - Restrictions on the use of computer-based assistive technologies - Financial constraints to accessing assistive technologies - Use of personal funds for devices - Self-initiated coping strategies, for example, self-affirmation and family support - Academic and psychological well-being negatively affected by learning without assistive technology

Source: Authors' own work.
Key: ICT, information and communication technology; AT, assistive technology.

access to educational resources. For example, a student without a visual impairment may be able to take books home to study over a holiday. However, a student with a visual impairment who relies on Braille services might not have the means to study as effectively outside the university.

Considering social contexts and the realities of inequalities can lead to more effective strategies and decision-making. The experiences from the three country contexts examined in the chapter shed light on the limitations some students with disabilities face regarding assistive technologies and the impacts on their educational experiences. Although this scoping review offers a somewhat narrow view, the experiences raise important questions about how much better education outcomes could be if assistive technologies were made affordable and accessible to all who need them.

The assistive technology needs of students with disabilities vary widely, and countries must invest in strategies that cater to these needs in all areas, including education. These investments can also promote digital inclusion and address digital inequalities by ensuring that persons with disabilities have equal opportunities to succeed in higher education. By prioritising accessibility, affordability and inclusion, countries can make significant progress towards creating a more equitable and just educational landscape for all students.

Limitations of the scoping review

Some limitations of this scoping review need to be acknowledged. Firstly, the review did not assess the quality of the included studies, nor did it extract data with rigour typically associated with a systematic review. Consequently, the accuracy and completeness of the data may be affected. Additionally, the comprehensiveness and generalisability of the conclusions are limited because of the relatively narrow synthesis of findings. Finally, the search strategy was not exhaustive, so some relevant studies may have been overlooked.

Despite the limitations, the review provides valuable insights into the use of assistive technologies by students with disabilities in the region. It suggests that a full systematic review would be feasible and relevant. A systematic review could provide a more detailed and comprehensive analysis, enhancing our understanding of this important topic.

Conclusion

The scoping review offers evidence supporting the feasibility and relevance of conducting a full systematic review on the use of assistive technologies by students with disabilities in southern African higher education.

The initial findings suggest growing research interest in understanding how assistive technology use affects students' educational experiences. However, there is an opportunity for further exploration across more southern African countries to develop a regional perspective.

While qualitative research has valuable attributes, such as shedding light on complex issues and providing holistic accounts of matters, the researcher tends to be given a primary role in data collection, analysis and interpretation. To enhance the depth and breadth of understanding of assistive technology use experiences, future studies should adopt participatory research methods that actively involve students with disabilities throughout the research process. This approach can promote knowledge transfer and generate evidence reflecting students' lived experiences.

The complexities of social contexts affect how disability and assistive technology are understood and experienced. The social constructions of both disability and assistive technology have significant implications for how higher education institutions address the education of students with disabilities and their use of assistive technologies. Future research should incorporate theoretical and conceptual frameworks that take into account the social dynamics surrounding disability and assistive technology. This approach will deepen our understanding of the inequalities in access to assistive technology and their impact on educational outcomes.

Finally, assistive technologies are integral to digital inclusion as they provide students with disabilities with the tools they need to access quality education. Digital inclusion ensures that all students, regardless of physical or cognitive abilities, can fully participate in technology-infused learning environments. However, without the widespread availability of assistive products in institutions, education inequalities will continue to persist and hinder the attainment of the SDGs.

Comprehensive systematic reviews should be conducted to consolidate and provide an analysis of existing research on assistive technology use in southern African higher education. These reviews should include non-English publications and grey literature to ensure a comprehensive regional understanding and capture diverse perspectives that might be overlooked in English-only studies.

Future studies should include perspectives from technical, vocational education and training institutions to provide a holistic view of assistive technologies used by students with disabilities across different educational settings. Understanding the unique challenges and opportunities in different types of institutions can lead to more targeted recommendations and interventions.

Higher education institutions should invest in establishing training programmes for students and staff on the use of assistive technologies. Moreover, infrastructure to support the integration of assistive technologies in teaching and learning should be improved. This investment will enhance digital literacy and ensure that assistive technologies are effectively used to support students' academic success.

Adequate funding should be made available to ensure that all students who need assistive technologies have access to them. This funding should cover buying the devices and support tools and their maintenance and upgrading. Ensuring financial support for assistive technologies is a means to promote digital inclusion and educational equity.

Higher education institutions should create platforms or spaces to address assistive technologies' emotional and/or psychological effects. This may require leveraging existing support systems such as counselling services and peer support networks or creating new forms of support. This will help students navigate the emotional challenges of assistive technology use and foster supportive learning environments.

Inclusive policies are integral to addressing the barriers faced by students with disabilities, and institutions should ensure that they develop and enforce policies that facilitate the integration of assistive technologies into educational environments. This way, they can chart concrete paths towards educational equity and digital inclusion, ensuring that all students have the opportunity to succeed regardless of their physical or cognitive abilities.

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Chapter 1

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Chapter 2

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Chapter 3

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Chapter 11

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Index

The book describes the digital inequality between well-connected communities and regions with access to information and communication technology (ICT) services and those that have difficulty accessing and using digital services. Despite the efforts made to enable the digital transformation of modern society, it is clear that the ground is not level. Some regions remain negatively affected and cannot access and use digital services. Beyond the economy, ICT also impacts the political, social and cultural spheres. Moreover, with recent advances in ICTs such as artificial intelligence, 3D printing and robotics, thinking about innovative ways of bridging the digital divide is becoming more essential.

Digital inequality in a developing context: A multifaceted approach uses practical case studies from selected Southern African countries to expose digital inequalities in different sectors, provides step-by-step solutions on closing the digital divide from a citizen's perspective and presents sustainable and achievable digital solutions to address the identified inequality.

Dr Fabrice Nzepang, Department of Economics, Faculty of Economics and Applied Management, University of Douala, Douala, Cameroon

Digital inequality in a developing context: A multifaceted approach addresses a gap in knowledge on the digital divide, focusing on numerous aspects and offering new ideas to overcome this challenge. It is evident from the secondary data collected in South Africa that there are digital inequalities in the main sectors such as education, healthcare and agriculture. These inequalities result primarily from social, technical and economic status, geography factors and urban-rural divides. To understand the concept of digital inequality in South Africa, one should focus on prevailing conditions such as availability of infrastructure, access to technology knowledge, economic factors and location. This book argues that if focused efforts are not put in place to advance infrastructure, affordability levels and public awareness, these imbalances will persist, and even impede, if not reverse socio-economic advances, and exacerbate existing inequalities in these essential sectors.

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