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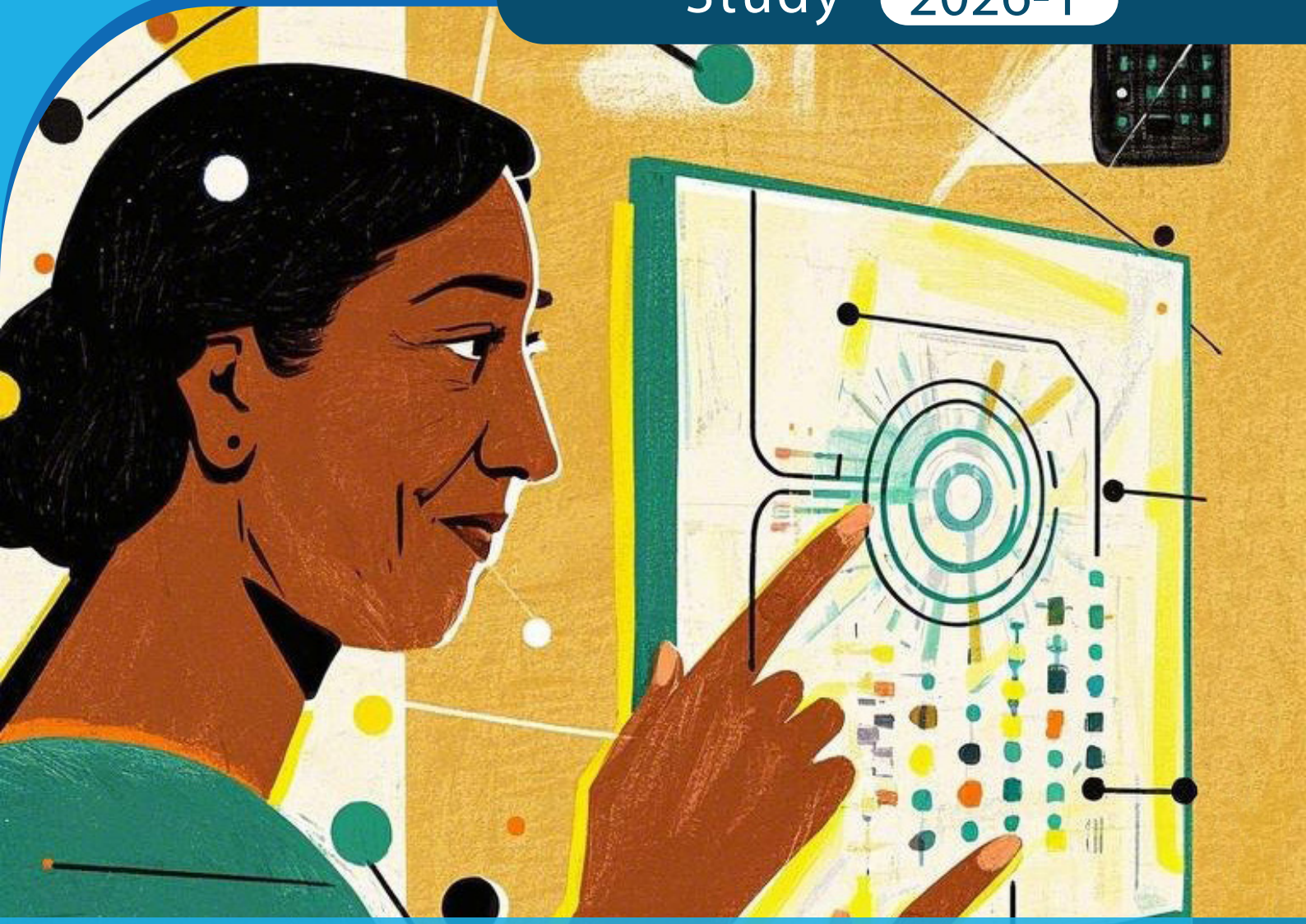

Digitalization and the Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study

January 2026

Edited by Quentin Wodon

In partnership with

African Union

Education 2030

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Table of Contents

Acknowledgements

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ICHEI Director's Message

Digital and artificial intelligence (AI) technologies are evolving rapidly, altering how knowledge is produced and accessed, how information circulates, and how societies organize economic and social activity. Against this backdrop, higher education institutions face growing expectations to rethink how they prepare learners for participation in an increasingly digitally advancing world. A holistic digital transformation approach to the higher education system has become a central priority for many and an irreversible trend of our time.

The African Union Agenda 2063 presents a strategic vision that positions innovation and education as core drivers of continental transformation, a vision that aims to strengthen human capital, expand equitable and effective learning opportunities, and advance Africa's long-term development. Yet higher education in Africa continues to face persistent gaps in digital resources, infrastructure, and AI literacy. Closing these gaps and accelerating digital transformation is therefore essential for enhancing educational quality, reducing capability disparities, and enabling the continent to achieve transformative and inclusive growth.

It is against this backdrop that the study "*Digitalization And The Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study*" was conceived. Jointly developed by the UNESCO International Institute for Capacity Building in Africa (UNESCO IICBA) and the International Centre for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI), the study provides a mapping of digitalization and AI practices across higher education institutions in Africa. Drawing on surveys of teachers and administrators, policy analyses, and institutional case studies, the study illustrates the current landscape of digital transformation, examines innovative practices, and analyzes the capacity-building needs of both educators and learners. By connecting policy environments with institutional practices, the report offers actionable insights and evidence-based recommendations for educators, university leaders, and policymakers committed to accelerating digital transformation in Africa.

Looking ahead, we remain convinced that a human-centered and well-governed digital transformation can expand learning opportunities and bridge digital gaps. Digital transformation is not merely a technological shift; it is a driver of greater equity, inclusion, and social progress. We hope this report will contribute to deep dialogue and cooperation, guiding us toward an inclusive and equitable higher education future.

Prof. JIN Li

Director, UNESCO-ICHEI

IICBA Director's Message

Digitalization and the use of artificial intelligence (AI) are fundamental changes affecting higher education in Africa. Case studies on how universities are adapting to these changes as well as frameworks to suggest ways to adapt can help higher education administrators, faculty, and even students make the best of the opportunities that digitalization and AI provide, while also avoiding some of the risks that may occur.

The idea to prepare this exploratory study on digitalization and AI in African higher education was suggested by the team and leadership at the International Centre for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI). At UNESCO's International Institute for Capacity Building in Africa (UNESCO IICBA), we are very grateful for this collaboration and the support provided by UNESCO-ICHEI.

The study consists of three parts: (i) reports on results from online surveys implemented among higher education stakeholders – including faculty, but also administrators; (ii) case studies documenting innovative experiences, typically at the level of specific universities but also in some cases with a broader scope; and (iii) a short final chapter that briefly outlines some of the frameworks and guidance documents available from UNESCO and the African Union on issues pertaining to digitalization and the use of AI in education.

We hope that the chapters assembled in this collection as well as future work we will engage in on this crucial topic will attract a broad readership. Dissemination events to share insights from the study will include a webinar as part of the Africa Teachers Webinar Series held by UNESCO IICBA together with the African Union, the Africa Federation of Teacher Regulatory Authorities, the European Union's Regional Teacher Initiative for Africa, and the Global Partnership for Education's Knowledge and Innovation Exchange (jointly with Canada's International Development Research Center).

If you have ideas for future work in this area, or comments on this study, please do not hesitate to reach out. There is no doubt that this topic is of crucial importance for Africa's future. We would love to expand the work and collaborate with a wide range of stakeholders to harness the potential of digitalization and the use of artificial intelligence to improve access to, as well as the quality of higher education in Africa.

Dr. Quentin Wodon

Director, UNESCO IICBA

Acronyms

AIMS	African Institute of Mathematical Sciences
AI	Artificial Intelligence
AAU	Association of African Universities
AUC	African Union Commission
AUF	Agence Universitaire de la Francophonie
BUSE	Bindura University of Science Education
CAMES	Conseil Africain et Malgache pour l'Enseignement supérieur
CESA	Continental Education Strategy for Africa
CETID	Centre for Educational Technologies, Innovation and Design
CPD	Continuous Professional Development
DESIP	Digital Education Strategy and Implementation Plan
GDP	Gross Domestic Product
HEI	higher education institutions
IAHSO	Artificial Intelligence, Humanities and Open Science
ICANN	Internet Corporation for Assigned Names and Numbers
ICHEI	International Centre for Higher Education Innovation
ICT	Information and Communication Technology
IICBA	International Institute for Capacity Building in Africa
IT	Information Technology
JKUAT	Jomo Kenyatta University of Agriculture and Technology
LMS	Learning Management Systems
MOOC	Massive Open Online Course
NUC	National Universities Commission
NUST	Namibia University of Science and Technology
ODL	Open and Distance Learning
ODLC	Open and Distance Learning Centre
PAU	Pan-African University
PAVEU	Pan-African Virtual and E-University
TPACK	Technological-Pedagogical-Content-Knowledge
TSC	Teacher Service Commission
TVET	Technical and Vocational Education and Training
UA	Universal Acceptance
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICAL	University of Calabar
UVCI	Université Virtuelle de Côte d'Ivoire

Chapter 1

Introduction and Overview

Quentin Wodon[1]

Introduction

Digitalization and the use of artificial intelligence (AI) are likely to transform higher education in Africa and elsewhere. To explore issues related to digitalization and the use of AI in higher education institutions (HEIs), UNESCO's International Institute for Capacity Building for Africa (UNESCO IICBA) and the International Centre for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI) agreed to collaborate to produce an exploratory study with a series of short essays and analyses. At the conceptualization stage, it was decided that the study would combine findings from an online survey ideally with respondents from all five regions in Africa (West, Central, East, Southern, and North Africa) and short case studies of interesting innovations and approaches with a focus on sub-Saharan Africa, thus excluding North Africa. The initial target countries for case studies were Cameroon for Central Africa, Kenya, Ethiopia, and Uganda for East Africa, South Africa and Zimbabwe for Southern Africa, and Nigeria, Ghana, and Senegal for West Africa, but with flexibility in changing countries based on opportunities from sharing innovative experiences.

Based on this initial conceptualization, this study (Wodon, 2025) consists of three parts. The first part reports on results from two online surveys implemented among higher education stakeholders – including faculty, but also administrators. The second part consists of case studies documenting innovative experiences, typically at the level of specific universities but also in some cases with a broader scope. Apart from an initial case study from the African Association of Universities, the other case studies cover Botswana, Cameroon (through the continental work of the Pan African University headquartered in Yaoundé), Côte d'Ivoire, Ghana, Ethiopia, Kenya, Namibia, Nigeria, Sierra Leone, South Africa, Togo, and Zimbabwe. These case studies are presented in Part II of the study alphabetically according to the country of focus. Finally, the third part of the study consists of a single short chapter that briefly outlines some of the frameworks and guidance documents available in UNESCO and African Union on issues pertaining to digitalization and the use of AI in education (links to selected references from the African Union and UNESCO are also available in an annex to this chapter).

Part I – Results from Online Surveys

Chapter 2 outlines key findings from an online survey on digitalization and the use of AI in higher education in Africa implemented specifically for this study. Given a small sample and the fact that the survey was not based on a sampling frame to ensure representativeness, one should be careful not to overstate the validity of the findings. Still, the findings are illustrative of some of the challenges and opportunities associated with digitalization and the use of AI as seen from faculty and other staff at HEIs. The focus is on five themes: (i) HEIs strategies, governance, and online resources; (ii) digital offerings for services and courses; (iii) student skills and institutional support; (iv) constraints to digitalization; and finally (v) perceptions regarding AI. While there are too many results to be reported in this introduction, it seems fair to say that in many HEIs, only limited progress has been achieved towards digitalization, and the work related to AI is even more in its infancy. There is also a difference by language, with respondents to the survey in French indicating less progress than those for the survey in English.

Chapter 3 is based on responses to a question on constraints to digitalization and the use of AI in higher education that was included in a separate online survey implemented to inform the new Continental Education Strategy for Africa 2026-2035 recently adopted by the African Union. The two most important constraints are a lack of funding and a lack of infrastructure, with both constraints likely related since the availability of infrastructure depends on funding. The next three most severe constraints are unsatisfactory remuneration or incentives, lack of professional development, and lack of technical support. Other constraints, which tend to relate more to the management of HEIs and the culture prevailing in those institutions (conservative academic culture, lack of leadership and vision, inadequate management model, lack

1 The author is with UNESCO's International Institute for Capacity Building in Africa (IICBA). The opinions expressed in this article are those of the author only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA add UNESCO-ICHEI and the members of its Governing Board.

of collaboration among peers, and faculty relatively old/not up to date) tend to be seen as less serious constraints. Thes findings are in coherence with those reported in Chapter 2.

Part II – Case Studies

Chapter 4 is about an initiative from the African Association of Universities to empower Directors of Information and Communication Technology (ICT) and Chief Information Technology Officers across African universities through capacity building. In the context of digitalization, the aim was to help ICT leaders with tools to manage governance, cybersecurity, enterprise resource planning systems, and institutional strategy. Together with the Internet Corporation for Assigned Names and Numbers (ICANN), a special focus was also placed on introducing and scaling Universal Acceptance of Domain Names and Email addresses in university systems. The initiative was successful, but sustaining the momentum will require continued effort. As the authors conclude, policy frameworks must evolve to support digitally inclusive practices, while university leaders must prioritize ICT integration into all aspects of university life and invest in human capital to be able to do so.

Chapter 5 focuses on the Pan-African Virtual and E-University (PAVEU), an initiative launched in 2019 by the Pan African University (PAU) which is headquartered in Cameroon but has a continental reach. PAVEU aims to expand access to higher education through online courses, certificates, and degrees. The authors draw three main lessons learned from the experience so far. First, digital education is only as strong as the institutional ecosystem that supports it. Beyond technology, attention must be paid to ensure the right human capacity and systems. Investing in dedicated teams for e-learning is required. Second, partnerships are key not only for course delivery but also for strategic orientation and relevance to African development priorities. Third, flexibility and accessibility are needed for participation with successful online courses including real-time check-ins, peer fora, and quick-response tutor support.

Chapter 6 tells the experience of the Université Virtuelle de Côte d'Ivoire (UVCI), a rapidly growing virtual university launched in 2015. Steps to create the online course offerings included the development of digital spaces for accessing scientific and technical information, studios for recording and editing educational videos, innovative third places (fabrication labs or fablabs and incubators) for prototyping, and support for faculty-researchers in pedagogical scripting and mediatization of course content and online practical work. Initial courses covered a wide range of offerings in IT and digital applications, but more recently, several other specialties covering digital humanities and societies, as well as digital management and economics, have been developed. Overall, UVCI has created a new technological ecosystem based in part on educational content production studios and learning platforms such as Moodle and Open edX, with the next step including the integration of AI, particularly generative AI, into educational devices.

Chapter 7 looks at digitalization and the use of AI in Ethiopian universities. As many other African countries, challenges abound for digitalization and the use of AI. Lack of funding is a key constraint, but other constraints matter as well. The first part of the case study focused on a diagnostic of constraints. Thereafter, findings from nine interviews with ICT Directors were shared. The interviews suggest a strong commitment in those universities to advancing higher education through technology and effective leadership, but digitalization nevertheless remains in its infancy stage. While innovations and efforts from the Federal Ministry of Education including the creation of platforms that serve all public universities are commendable, a national strategy for digitalization and AI in higher education is probably needed to fully harness their potential and respond to demand from HEIs for digitalization and AI solutions.

Chapter 8 looks at digitalization and the use of AI in Ghanaian Universities. Ghana's government is preparing an AI strategy, which will contribute to the larger so-called digital transformation agenda already underway. The author provides a brief diagnostic of the state of digitalization in Ghanaian universities, including existing laws, investors, and partnerships. Examples of success are shared, as well as five key obstacles: weak infrastructure, lack of specialist staff, fragmented decision-making, patchy data protection, and limited funding to keep talent at home. Suggestions for the way forward are then provided.

Chapter 9 documents the creation of a Master of Science (MSc) in Artificial Intelligence at the Pan African University of Basic Sciences, Technology and Innovation, one of the campuses of the Pan African University. The study explores how stakeholders were involved in developing the new program and ensuring the relevance of its curriculum for industry. The degree will start in the coming academic year as a two-year program delivered on a full-time basis through face-to-face instruction combined with labs, seminars, and project-based learning. Core units will include machine learning, deep learning, generative AI, large language models, natural language processing and computer vision, plus a course on the ethics of AI as well as grounding in research methods and thorough engagement with industry stakeholders.

Chapter 10 is a case study for the University of Calabar in Nigeria, with a focus on the digitalization of the Postgraduate School and the launch of an Open and Distance Learning Centre. Digital platforms have enhanced administrative efficiency, expanded access to learning for non-traditional students, and sparked growing interest in the use of AI. The authors stress the need to prioritize stable electricity and high-speed internet, and the formulation of an institutional Digital Education and AI Integration Policy to standardize expectations, outline roles and responsibilities, and guide ethical use of AI. Targeted capacity-building programs for digital pedagogy, AI applications in education, and digital content development are all needed. For sustainability, partnerships with EdTech firms, AI research hubs, donor agencies, and regulatory bodies would be beneficial for funding, infrastructure support, and access to AI-powered tools.

Chapter 11 is adapted from previous work on teacher continuous professional development (CPD) in Sierra Leone. Teacher education, often provided by HEIs, is key to improving teaching and learning, especially in a context where many teachers do not have the minimum qualifications needed for teaching. After a broad discussion of issues pertaining to both pre- and in-service education, findings are shared from an online survey on teachers and school leaders' perceptions of their digital skills and their ability to connect to the internet. Most teachers and school leaders feel they have good knowledge and skills for using computers, the internet, and online resources but there is a lack of access to computers, laptops, tablets, or the internet in schools. In terms of priority needs for CPD, teachers and leaders emphasize capacity building in teaching methodologies and the use of educational technologies, with school leaders also emphasizing training for leading professional knowledge, practice and conduct in their school.

Chapter 12 uses a mixed method approach to assess perceptions of pre-service science teachers toward adopting AI in education in South Africa. Pre-service teachers tend to have positive attitudes and intentions toward AI integration (albeit with differences between universities), but constraints include weak technological infrastructure, limited teacher preparedness, lack of administrative support, funding constraints, and cultural and pedagogical resistance. Regarding technological-pedagogical-content-knowledge, comprehensive technological training appears to foster effective AI adoption. As to cultural and pedagogical resistance, it may require targeted professional development on the complementary rather than substitute role of AI in enhancing as opposed to replacing the role of the teacher.

Chapter 13 explores digitalization at the University of Kara in Togo. A key challenge is the lack of large lecture halls to accommodate the rapidly growing student population, which has required extending the academic year and affected learners and teaching and administrative staff, including with overtime. A larger number of students has also led to higher costs and a burden on instructors, for example to process students' papers or printing exam flaps. These conditions contributed to the university embarking on a digitalization journey. At the time of writing, 12,000 teaching units divided into 185 courses, were offered in hybrid format, so that at least 20 percent of the teaching content was delivered online via the Moodle platform for all 22,000 students regularly enrolled. Digitalization has also made it possible to provide support for the visually impaired (digital library transcribed in audio format) and has strengthened plagiarism control, including for master's and doctoral dissertations. Going digital, however, required addressing challenges related to the digital divide, leadership, and networking decentralized services.

Chapter 14 is a case study on digitalization and the use of AI at Bindura University of Science Education (BUSE) in Zimbabwe. Through the establishment of a Centre for Educational Technologies, Innovation and Design, the adoption of digital learning platforms, the integration of AI tools, and sustained capacity-building efforts, major progress has been achieved, but challenges remain in terms of infrastructure, gaps in digital literacy, a lack of AI governance frameworks, and limited financial resources. Recommendations made by the authors include developing a digital and AI policy, enhancing faculty and student digital competencies, improving the infrastructure and connectivity, establishing an innovation and research hub for AI in education, and strengthening regional and global collaboration.

Chapter 15 looks at how the Namibia University of Science and Technology (NUST) is deploying AI, focusing on strategic interventions, pedagogic innovations, and ethical considerations for both teachers and students. The aim is to make AI an integral part of the way teachers and students work, communicate, and collaborate, emphasizing the development of key AI competencies in part through self-paced eLearning courses for both teachers and students. Innovative pedagogies, such as the flipped classroom, help to optimize the time teachers spend with students face-to-face and what students can do online. Human agency and quality learning are the aim in an AI-infused space maintaining academic integrity.

Chapter 16 considers the experience of digitalization and the use of AI at Botswana Open University whose mandate is the democratization of access to higher education and training through flexible learning environments. BOU's predecessor, BOCODOL, relied on traditional correspondence education with printed learning materials shared via postal service and infrequent face-to-face tutorials. A strategic shift began with the adoption of a Learning Management

System that became the hub for course delivery and was accelerated by the COVID-19 pandemic. Recent AI initiatives include AI-Powered Chatbots, automated assessment and feedback, predictive learning analytics, the use of generative AI for content, academic integrity tools, a BOU mobile app, online ethics clearance, and an integrated technology system.

Part III – Guidance Documents

Finally, chapter 17 considers existing frameworks for digital competencies and the use of AI with a focus on teachers and education systems. The chapter has two aims. The first aim is to introduce to readers a few global concepts and frameworks that can help frame discussions on digitalization and the use of AI with a focus on the competencies that teachers need to acquire. This includes brief overviews of UNESCO's ICT competency framework for teachers and its recent AI competency framework for teachers. The second aim is to outline continental strategies and recommendations recently adopted by the African Union to inform the work of Member States. While other documents are also briefly discussed including on the ethics of AI, a special focus is placed on the African Union's Digital Education Strategy and Implementation Plan and the recently approved Continental Artificial Intelligence Strategy for Africa.

Conclusion

The potential benefits of digitalization and the use of AI in African higher education are huge, including for upgrading teaching, learning, research, and administration. But there are also risks and occasionally some resistance among HEI faculty and staff pertaining not only to ethical issues, but also to perceptions that AI especially may weaken the role of teachers, while also affecting the ability of students to learn material in enough depth. At a practical level, even when there is a desire among HEIs to strengthen digitalization and the use of AI, constraints abound, whether in terms of the available infrastructure and connectivity, funding, or skilled personnel, to name a few. The hope however for this study is that by sharing a patchwork of case studies on innovations in HEIs across Africa, it will contribute to encouraging HEIs to invest in those areas, so that African HEIs are not left behind. When implemented well, digitalization and the use of AI can help make higher education accessible to a wider range of students and lead to major improvements in both teaching and learning.

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Wodon, Q., Editor (2025). *Digitalization and the Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study*. Addis Ababa, Ethiopia, and Shenzhen, China: UNESCO IICBA and UNESCO-ICHEI.

Annex: Selected African Union and UNESCO Guidance Documents on Digitalization and AI

This annex provides links to selected African Union and UNESCO guidance documents on digitalization and AI. More resources are available on UNESCO IICBA's Africa Education Knowledge Platform.

What Does AI Mean for Education Systems?

As stated in the African Union's *Continental Artificial Intelligence Strategy* (2024), AI may contribute to Africa's socio-economic transformation and cultural renaissance. On education, high level recommendations emphasize formulating inclusive national policies or strategies related to AI in education, supporting AU Member States to develop national AI competencies for teachers and students, and investing in training educators and students in AI technologies, coding, and data science.

The African Union's *Digital Education Strategy and Implementation Plan* (2024) considers three essential themes of AI in education: learning with AI, learning about AI, and preparing for AI. It outlines AI Readiness in six sections: Ethical considerations; AI application in data and analytics; EdTech Entrepreneurs' adoption of AI; Research on the implication of digital education; Digital Literacy, Skills and Certification for Teachers; and Digital Literacy, Skills and Coding for Students.

AI and education: guidance for policy-makers (2021) helps policy makers leverage opportunities and address risks as connections between AI and education systems grow. This guidance consists of three sections: A brief introduction to AI; a discussion of how AI can enhance inclusion and equity, quality of learning, education management, and pedagogy; and a set of recommendations designed to inform a comprehensive vision and action plans for AI-and-education policies.

Guidance for generative AI in education and research (2023) is UNESCO's first global guidance on generative AI (GenAI) in education to support countries in implementing actions and planning policies related to GenAI. This document discusses among others the followings: Regulation of the use of GenAI in education; A framework with specific measures complementing recommendations on the above guidance; Facilitation of the use of GenAI; and GenAI and the future of education and research.

Ethics in AI

UNESCO's Recommendation on the Ethics of Artificial Intelligence: Key Facts (2023) addresses ethical issues related to AI, including: The importance of global recommendations on the ethics of AI; A human-rights approach to AI; Actionable policies; and Implementing the recommendations. Central to the recommendations are four core values that lay the foundations for AI systems serving humanity, individuals, societies, and the environment.

AI and the future of education: disruptions, dilemmas and directions (2025) explores the philosophical, ethical and pedagogical dilemmas posed by the potentially disruptive influence of AI in education. The document contains nine chapters, including: Revaluing and recentering human teachers; AI pedagogies, assessment, and emerging education future; and Reimagining AI in education policy: evidence and geopolitical realities.

AI and education: protecting the rights of learners (2025) comprises of two main components: Prioritizing a human-centered and rights-based use of digital technology to benefit all learners; and Calling for urgent national and international action to ensure that technology enhances, rather than endangers, the right to education for all. The document notes that the right to privacy, or the right to a private life, is firmly grounded in several key international and regional human-rights instruments.

AI Competency Frameworks for Teachers and Students

AI Competency Framework for Teachers (2024) supports the design of national AI competency frameworks for continuous professional development and related assessment tools. The framework articulates principles such as protecting teachers' rights, enhancing human agency, and promoting sustainability. It also sets out 15 competencies, categorized by aspects and progressions.

AI Competency Framework for Students (2024) supports teachers and educators in building proactive education systems that prepare students to be responsible users and co-creators of AI. This framework outlines domain-specific pedagogical methodologies across four competencies and three progression levels.

Part I

Results from Online Surveys

Chapter 2

Digitalization and Artificial Intelligence in African Higher Education: Results from an Online Survey

Quentin Wodon, Hungi Njora, and Temechegn Engida[2]

Introduction

Digitalization and the use of artificial intelligence (AI) are among the main challenges faced today by education systems, including higher education institutions (HEIs) in Africa and globally. These challenges and related opportunities have been recognized in policy documents globally (UNESCO, 2023) and in Africa, including most recently in the new Continental Education Strategy for Africa 2026-2035 (African Union Commission, 2025a; see also African Union Commission, 2025b for a review of the previous strategy) and the Continental Artificial Intelligence Strategy (African Union Commission, 2024). Various studies have also been conducted, especially by UNESCO-ICHEI (International Centre for Higher Education Innovation), on emerging good practice in digitalization and the use of AI. This includes a study for Africa (Prinsloo et al., 2024) as well as studies for Southeast Asia (Pannen et al., 2024), Central Asia (Rakhmatullaev, 2024), Latin America and the Caribbean (UNESCO IESALC and UNESCO-ICHEI, 2024a), and the Arab Region (ALESCO and UNESCO-ICHEI, 2023).

Data about the extent to which HEIs in Africa are prepared for the transformation that digitalization and AI will bring are however scarce, whether in terms of the available infrastructure including connectivity to the internet, the training of faculty and administrative staff, or the readiness of students to benefit from digitalization. These issues were already identified previously, including in the African Union's Digital Transformation Strategy for Africa 2020-2030 and guidance for digitalizing teaching and learning (African Union Commission, 2020a, 2020b), although often with a stronger focus on basic than higher education.

In this chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), specific challenges faced in HEIs are illustrated based on data from an online survey. The chapter provides summary results from an online survey on digitalization and the use of AI in higher education in Africa. The survey was implemented in 2025 among faculty members and staff at HEIs across Africa. Several organizations helped disseminate the survey, including the African Association of Universities, CAMES (*Conseil Africain et Malgache pour l'Enseignement supérieur*), and UNESCO-ICHEI. The sample for the survey is relatively small with just under 200 respondents and there may be biases related to the reliance on online contacts to disseminate the survey. One cannot therefore assume that the sample and results are representative of faculty and staff at HEIs across the continent. Still, the results of the survey are illustrative of common perceptions regarding digitalization and the use of AI in higher education in Africa. The results also seem to make sense. For example, constraints faced by faculty and staff in the survey are similar to constraints mentioned in a separate and larger survey implemented to inform the new Continental Education Strategy for Africa 2026-2035 (that survey is discussed in Chapter 3 in this study). The perceptions revealed by the survey also echo many of the observations made in the case studies included in this study. In short, while one should not assume that findings from the survey are representative of perceptions across the sector in a statistically robust way, they are nevertheless indicative of perceptions among faculty and staff.

In what follows, a brief profile of respondents to the survey is first provided. The next three sections describe findings from the survey related to HEIs strategies, governance, and online resources, digital offerings for services and courses, student skills and institutional support, constraints to digitalization, and finally perceptions regarding AI. A brief conclusion follows.

2 The authors are with UNESCO's International Institute for Capacity Building in Africa (IICBA). They are grateful to Zixuan Liu for inputs in designing the online survey on which this chapter is based. The opinions expressed in this article are those of the authors only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA.

Profile of Survey Respondents

This section provides a rapid overview of the profile of survey respondents, considering the surveys in both English (N=94) and in French (N=89). In what follows, EN will refer to respondents to the survey in English while FR will refer to respondents to the survey in French. In both surveys, men accounted for most of the responses (EN 76 percent, FR 87 percent). In terms of age groups, respondents in the English survey were slightly younger (largest age group consisting of individuals aged 35 to 44 years) than in the French survey (largest group aged 45 to 54 years). The highest academic qualification completed is typically the PhD (EN 57 percent and FR 99 percent). For the English sample, in the absence of a PhD, most other respondents had a master's degree, although a few respondents only had a Baccalaureate degree or less.

In terms of country representation, Ethiopia and Nigeria had the largest number of respondents in the English survey. In the French survey, Cote d'Ivoire had the most respondents. About half of the other African countries were represented in either of the two surveys. Respondents work overwhelmingly in public universities (EN 82 percent, FR 99 percent), with their institutions located for the most part in urban areas (EN 94 percent, FR 92 percent). In terms of their position, most respondents are in academic positions such as professors, lecturers, or researchers (EN 60 percent, FR 83 percent), but other roles are also represented, including administrative (e.g., registrar, admissions officer), management (e.g., president, dean, director, department head), support staff (e.g., IT, library, facilities), or other positions. In terms of their disciplines, respondents come from virtually all disciplines, although larger proportions are engaged in the social and natural sciences[3]. Most respondents come from institutions providing instruction mostly in person, but a substantial minority of students also study online or in hybrid mode. In terms of the digital learning provided by the institutions, while more respondents work for institutions serving primarily undergraduate students online, many institutions also serve postgraduate students and professionals in need of continuous professional development online.

Strategies, Governance, and Online Resources

Asked whether their institution has a strategy for digitalization, most respondents respond in the affirmative (EN 88 percent, FR 79 percent). When such a strategy exists, it is typically not stand-alone document, but rather part of the overall institutional strategy or plan (EN 52 percent, FR 49 percent) or related to a national digital education strategy or plan (EN 28 percent, FR 27 percent). In both the English and French surveys, the respondents' institutions support the development of digitalization mostly through central units for digitalization and/or for learning and teaching that include a focus on digitally enhanced teaching and learning, and less so through school- or departmental-level units. Respondents were also asked whether their institution has a strong digital communication strategy for keeping students and staff informed through online platforms. In both surveys, just over half of respondents responded in the affirmative (EN 64 percent, FR 57 percent), suggesting a need for progress in this area as well.

In terms of coverage of various topics in the institutions' policies towards digitalization, including data protection, cyber security, intellectual property, ethics and integrity, examination and testing, research, internal quality assurance, and the detection and prevention of plagiarism, there is broad consistency across topics in the share of institutions with policies covering the topics (EN 42 to 61 percent, FR 40 to 60 percent), with the exception in the French survey for cyber security and intellectual property, which both score lower (at respectively 26 percent and 36 percent). When topics are not yet covered in the institutions' policies, in most cases respondents suggest that policies are being developed, although between a tenth and a third of respondents stated that they do not know whether various areas are covered or not in their institution's policy, with those proportions higher in the French survey.

In terms of online resources, respondents were asked if their university library offered a significant collection of online academic resources, considering e-books, journals, and databases. A substantial difference was observed between the two surveys, with a much larger share of respondents in the English survey responding in the affirmative (e-books 67 percent, journals 62 percent, and databases 58 percent) than in the French survey (e-books 34 percent, journals 37 percent, and databases 31 percent).

3 Disciplines were identified as follows: Humanities (Literature, Linguistics, History, Philosophy, Classics, Art History, etc.), Social Sciences (Psychology, Economics, Sociology, Anthropology, Political Science, International Relations, Education, etc.), Natural Sciences (Physics, Chemistry, Biology, Geology, Environmental Science, Astronomy, etc.), Formal Sciences (Mathematics, Statistics, Computer Science, etc.), Applied Sciences (Engineering, Architecture, Information Technology, Agriculture, etc.), Medical Sciences (Medicine, Public Health, Pharmacy, Dentistry, Nursing, etc.), Business Management (Finance, Accounting, Business Administration, Marketing, Human Resource Management, etc.), Arts (Visual Arts, Performing Arts, Film and Media Studies, etc.), Law, and Other.

Digital Offerings for Services and Courses

Respondents were asked whether various services were offered online, including registration, course selection, fee payment, access to academic records/grades, application for scholarships/grants, exam scheduling and results, student support services (e.g., counseling, advising), and housing or accommodation services. Table 1 provides the share of respondents responding in the affirmative in both surveys. Except for registration where respondents in the survey in French suggest more availability online and student support services (e.g., counseling, advising) where there is a virtual tie and low level of access online in both surveys, online accessibility tends to be higher in the survey in English than in French.

Table 1: Share of Respondents Indicating that Various Services Are Available Online (%)

	Survey in English	Survey in French
Registration	69%	85%
Course selection	63%	32%
Fee payment	71%	64%
Access to academic records/grades	68%	38%
Application for scholarships/grants	53%	50%
Exam scheduling and results	63%	52%
Student support services (e.g., counseling, advising)	35%	37%
Housing or accommodation services	46%	30%

Source: Authors, from the online survey on digitalization and AI in higher education.

Respondents were asked whether their institution offers the following delivery modes for courses and degrees: blended learning, fully online degree program, massive open online courses (MOOCS), virtual student mobility, and online short courses that earn certificates, micro-credentials, badges or a similar qualification. Four responses could be given: yes throughout the institution, yes in some faculties/colleges/schools, not yet but we are planning to, and no, with an additional modality for "I do not know/not applicable." Using a four-point scale to summarize responses from 1 (No) to 4 (yes throughout the institution), Table 2 provides the average answers. Blended learning is clearly emerging in a substantial way, but other approaches to online learning are still lagging in both surveys.

Using the same scale, a question was also asked about whether institutions integrate digital skills into their programs and operations, with a focus on both specific skills related to the discipline/study field and broader topics such as digital literacy, ethics and behavior in digital environments, and data and information safety/cyber security. As shown in Table 2, ratings are slightly better for respondents in the survey in English but remain low for the survey in French except for skills related to specific disciplines, suggesting a need for more mainstreaming. Again, using the same scale, respondents were asked if they witnessed at their institution a growing trend towards digital (e-)assessment. This shift is observed to some extent, but when this is the case, it tends to apply for all courses as opposed to online courses only.

Table 2: Degree to Which Institutions Provide Online Learning Options (4-point Scale)

	Survey in English	Survey in French
Types of Online Offerings		
Blended learning	2.5	2.3
Fully online degree program	1.7	1.7
Massive Open Online Courses (MOOCs)	1.6	1.5
Virtual student mobility	1.6	1.4
Online short courses for certificates, micro-credentials, badges or similar	1.9	1.8
Integration of Digital Skills in Programs and Operations		
Specific to the discipline/study field	2.6	2.4
General digital literacy	2.8	1.9
Ethics and behavior in digital environments	2.4	1.9
Data and information safety/cyber security	2.4	1.9
Growing trend towards digital (e-) assessment		
For all types of courses	2.6	2.1
Only for online courses	2.0	1.9

Source: Authors, from the online survey on digitalization and AI in higher education.

Student Skills and Institutional Support

Are students digitally savvy? Respondents were asked to rate their students' digital skills in various areas on a five-point scale, from not at all capable to very capable. Average ratings are provided in Table 3. In the survey in English, while respondents feel that students tend to have basic computer skills and some level of digital communications skills, but other skills – online research skills, multimedia skills, skills in using learning platforms, and especially coding and programming, are rated lower. In the survey in French, for all types of skills, ratings are relatively low. This suggests that students need support in this area. Typically, though, the support provided by universities to students focuses more on providing access to the internet together with managing a center or unit for technical support than more advanced support such as providing courses for digital skills, supporting digitally enhanced learning, or providing devices. As to support for teaching faculty, the focus is more on digital skills training opportunities than other forms of support, including online platforms for exchange and collaboration of teachers, open educational resources opportunities, or the provision of centers/units that support teachers on all technical issues or digitally enhanced teaching and learning. There is also a systematic difference in responses between the surveys in English and French, with support provided to both students and teachers higher in the survey in English than the survey in French.

Table 3: Skills Level of Students (5-point Scale) and Support Provided to Students and Teachers (%)

	Survey in English	Survey in French
Skills Level of Students (5-point scale)		
Basic computer skills	3.4	3.1
Online research skills	2.9	3.0
Digital communication skills	3.3	3.0
Multimedia skills	3.1	2.9
Using learning platforms	3.1	2.8
Coding and programming	2.4	2.0
Support Provided to Students (%)		
Courses for digital skills	64%	36%
A center/unit that supports students on digitally enhanced learning	65%	48%
A center/unit for technical support	73%	47%
Access to devices	61%	42%
Access to Internet	85%	59%
Support Provided to Faculty (%)		
Digital skills training opportunities	74%	60%
Online platform for exchange and collaboration of teachers	59%	52%
Open educational resources (OERs) opportunities	54%	36%
A center/unit that supports teachers on all technical issues	60%	45%
A center/unit that supports teachers on digitally enhanced teaching and learning	65%	40%

Source: Authors, from the online survey on digitalization and AI in higher education.

Constraints to Digitalization

Respondents were asked to what extent various factors were barriers or constraints to digitalization in their institution, with potential ratings ranging from "to no extent at all" up to "to a very high extent", corresponding to a Lickert scale with six ratings. The potential constraints listed were lack of infrastructure (e.g., insufficient internet, insufficient equipment); conservative academic culture; lack of funding opportunities; lack of technical support, lack of leadership and vision, centralized management model of the institution, lack of collaboration among peers, unsatisfactory remuneration, lack of motives for innovation, inadequate administrative organization, lack of support of professional development, lack of sufficient skills by educators to use digital technologies, lack of sufficient skills by students to use digital technologies, lack of student access to devices, lack of educator access to devices, and other constraints. Table 4 provides simple averages of the ratings from 1 (to no extent at all) to 6 (to a very high extent). The higher the average rating, the more important a constraint is perceived to be. Lack of infrastructure (e.g., insufficient internet or equipment) is seen as the most important constraint in both surveys, with fewer differences among other constraints, although in the French survey lack of funding seems a lesser issue.

Table 4: Ratings for Perceived Constraints to Digitalization (6-point Scale)

	Survey in English	Survey in French
Lack of infrastructure (e.g., insufficient internet or equipment)	4.3	4.8
Conservative academic culture	3.3	2.8
Lack of funding opportunities	2.5	1.9
Lack of technical support	3.2	2.8
Lack of leadership and vision	2.8	2.6
Centralized management model of the institution	2.8	2.7
Lack of collaboration among peers	2.9	2.6
Unsatisfactory remuneration	2.8	2.6
Lack of motives/incentives for innovation	3.1	2.6
Inadequate administrative organization	3.2	2.4
Lack of support for professional development	3.1	2.7
Lack of sufficient skills by educators to use digital technologies	3.0	2.8
Lack of sufficient skills by students to use digital technologies	2.9	2.6
Lack of student access to devices	2.7	2.3
Lack of educator access to devices	2.8	2.6

Source: Authors, from the online survey on digitalization and AI in higher education.

Respondents were then asked if over the past five years, digitalization at their institution had contributed to major transformations in a range of areas including teaching and learning methods, improvement of quality of teaching and learning, improvement of access and inclusion (e.g., for lifelong learning, disadvantaged learners), provision of open learning opportunities, collaboration with other higher education institutions at national level, collaboration with other higher education institutions at international level, collaboration with employers/industry, collaboration with society/community, research collaboration, outreach and learning provision for international students, the shift from physical mobility to virtual mobility and online meetings, and improved organization & administration of the institution. Key results are provided in Table 5 based on a five-point scale from strongly disagree to strongly agree, with an additional option for "I don't know/Not applicable." Average ratings on a scale from 1 to 5 are provided in the Table, suggesting some gains in terms of transformation, with slightly better ratings according to respondents to the survey in English as compared to the survey in French, and relatively few differences across categories in terms of the contribution of digitalization to transformation.

Table 5: Ratings for the Extent to which Digitalization Contributed to Transformation (5-point Scale)

	Survey in English	Survey in French
Teaching and learning methods	3.5	3.1
Improvement of quality of teaching and learning	3.6	3.2
Improvement of access/inclusion (e.g., lifelong learning, disadvantaged learners)	3.2	2.8
Provision of open learning opportunities	3.5	3.3
Collaboration with other higher education institutions at national level	3.5	3.2
Collaboration with other higher education institutions at international level	3.4	3.1
Collaboration with employers/industry	3.2	2.6
Collaboration with society/community	3.3	2.8
Research collaboration	3.6	3.3
Outreach and learning provision for international students	3.2	2.8
Shift from physical mobility to virtual mobility and online meetings	3.4	3.1
Improved organization and administration of the institution	3.3	3.0

Source: Authors, from the online survey on digitalization and AI in higher education.

Perceptions Regarding AI

The last part of the survey focused on perceptions related to AI. Respondents were asked to what extent higher education would be affected by AI. As shown in Table 6, there was a major difference between respondents in the survey in English, most of whom felt that AI would affect higher education very much, and respondents in the survey in French, where the level of disruption that AI could bring was felt to be a bit lower. Respondents were also asked to what extent

AI could be beneficial in higher education in various areas, namely personalized learning, grading and assessment, research assistance, administrative tasks, accessibility and inclusion, resource management, supporting creativity, student engagement, and curriculum design. By and large, on a 6-point scale, there are few differences in ratings between areas (Table 6), but in both surveys, research assistance is the area that is perceived as likely to benefit the most from AI. While this is not surprising, it may also suggest that the benefits of AI for other areas may not yet have been fully internalized. In terms of perceived risks from AI, in both surveys, risks related to plagiarism and the development of students' critical thinking were perceived to be more prevalent than risks related to AI potentially undermining the role of the educator or contributing to inequality or discrimination.

Still another question asked to respondents aimed to identify areas where their institution, its students, or the faculty may already have used AI. Summary responses also provided in Table 6 suggest that students may have used AI more than institutions or teachers so far, including for their study and for activities outside of the school. Few institutions (one in five) seem to have policies in place for students or staff on the use of AI, even if there is awareness of potential risks arising from students' use of AI. Finally, AI has not been systematically used in administrative or educational processes in most institutions.

Table 6: Perceptions Regarding AI (Scale or %)

	Survey in English	Survey in French
How Much Will AI Affect Higher Education?		
Very much	71%	39%
Much	20%	48%
Moderately	6%	9%
Slightly	1%	3%
Not at all	1%	0%
Potential Benefits from AI (6-point Scale)		
Personalized learning	4.9	4.8
Grading and assessment	4.6	4.5
Research assistance	5.1	5.3
Administrative tasks	4.8	4.7
Accessibility and inclusion	4.8	4.5
Resource management	4.9	4.7
Supporting creativity	4.8	4.7
Student engagement	4.6	4.5
Curriculum design	4.8	4.7
Use of AI		
Institution used tools in the educational process that include AI	39%	26%
University students use AI tools for their study	69%	64%
University students use AI tools outside their school activities	56%	53%
University instructors use AI for teaching and learning purposes	50%	44%
School uses AI for administrative tasks (registration, grades, absences, etc.)	22%	11%
Awareness of potential risks arising from students' use of AI tools	62%	80%
Institution has AI-related policies for staff	19%	6%
Institution has AI-related policies for students	21%	12%
Perceived Risks of AI (5-point Scale)		
AI could undermine the role of the educator	3.4	3.4
AI could lead to new forms of inequality/discrimination or exacerbate existing ones	3.5	3.3
AI could become an obstacle to students' thinking, especially critical thinking.	3.8	3.7
AI could lead to more plagiarism.	3.7	3.9

Source: Authors, from the online survey on digitalization and AI in higher education.

Much in the same way that a question was asked on constraints to digitalization, a similar question was asked about constraints to the use of AI. Respondents could assess constraints with ratings on a 5-point scale ranging from "not at all important" up to "highly important". The constraints listed were lack of infrastructure, the cost of investment/maintenance in technology, teachers not having sufficient technical skills to implement AI effectively in classrooms,

students not having enough knowledge to use AI effectively, lack of specialists in Africa to integrate AI in higher education institutions, traditional teaching methods remaining dominant in classrooms and reluctance to change, lack of policy frameworks for guiding the use of AI, ethical/legal concerns for the use of AI, limited availability of AI tools tailored to higher education needs, limited training for teachers to use AI, and lack of awareness about ai tools.

Table 7 provides simple averages of the ratings from 1 (not at all an important constraint) to 5 (highly important constraint). The higher the average rating, the more important a constraint is perceived to be. As for the obstacles to digitalization, lack of infrastructure is seen as the most important constraint in both surveys (with a few ties in the survey in French), but many other constraints come out strongly as well, although students not having technical knowledge and reluctance to change come out less strongly.

When respondents were asked about their interest in receiving guidance in using AI tools, there was strong interest for all of the areas listed in the survey, namely personalized learning, grading and assessment, research assistance, administrative tasks, accessibility and inclusion, resource management, supporting creativity, managing how students use AI, and ethical use of AI, although interest was slightly lower for administrative tasks, accessibility and inclusion (Table 7). Finally, on the potential effectiveness of alternative methods to train university educators on AI systems, on a 6-point scale, training seminars and workshops were rated highest, but pre-service teacher education, specialized online courses (e.g. MOOCs), and the provision of appropriate educational material were also considered to be useful.

Table 7: Constraints Limiting the Use of AI in Higher Education (Scale or %)

	Survey in English	Survey in French
Constraints for the Use of AI (5-point Scale)		
Lack of infrastructure (access to computers, internet, data, etc.)	4.2	4.1
Investment/maintenance in technology too high for higher education institutions	3.9	3.9
Teachers not having sufficient technical skills to implement AI effectively in classrooms	3.7	3.4
Students not having the technical knowledge to use ai effectively in their learning	3.5	3.3
Lack of specialists in ai in Africa to integrate AI into higher education institutions	3.8	3.6
Traditional teaching methods dominant in classrooms and reluctance to change	3.5	3.4
Lack of policy frameworks for guiding the use of AI in education	3.9	3.9
Ethical/legal concerns for use of AI, including plagiarism, accountability, etc.	4.0	4.1
Limited availability of AI tools tailored to higher education needs	4.0	4.1
Limited training for teachers to use AI	4.0	4.1
Lack of awareness about AI tools	3.9	3.9
Interest in Receiving Guidance in Using AI Tools (yes/no)		
Personalized learning	95%	90%
Grading and assessment	84%	91%
Research assistance	95%	100%
Administrative tasks	89%	82%
Accessibility and inclusion	90%	80%
Resource management	92%	87%
Supporting creativity	91%	89%
Managing how students use AI	94%	91%
Ethical use of AI	90%	92%
Effectiveness of methods to train university educators on AI systems		
Pre-service teacher education	4.9	5.0
Training seminars/workshops	5.3	5.4
Specialized online courses (e.g. MOOCs)	4.9	5.2
Provision of appropriate educational material (textbooks and other material)	4.9	5.5

Source: Authors, from the online survey on digitalization and AI in higher education.

Conclusion

This chapter distilled key findings from an online survey on digitalization and the use of AI in higher education in Africa. Given a small sample and the fact that the survey was not based on a sampling frame to ensure representativeness, one should be careful not to overstate the validity of the findings. Still, the findings are illustrative of some of the challenges and opportunities associated with digitalization and the use of AI as seen from faculty and other staff at HEIs. The focus in the discussion was on five themes: HEIs strategies, governance, and online resources, digital offerings for services and courses, student skills and institutional support, constraints to digitalization, and finally perceptions regarding AI.

Many findings are as one might have expected, with a relative lack of preparedness of HEIs to confront the challenges (and take advantage of the opportunities) that digitalization and AI may generate. Digitalization is still in its infancy in many institutions, and while AI is seen as likely to yield major changes to the sector, students, teachers, and administrators have not fully grasped those changes yet. One finding across many questions in the survey is that the level of engagement with digitalization and AI seems to be lower in francophone than anglophone Africa. Overall, the results point to the need for HEIs as well as national authorities to invest more towards relieving the constraints for digitalization and the use of AI.

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Chapter 3

Constraints to Digitalization and the Use of Artificial Intelligence in Higher Education: Insights from Data Collected for the Continental Education Strategy for Africa

Quentin Wodon[4]

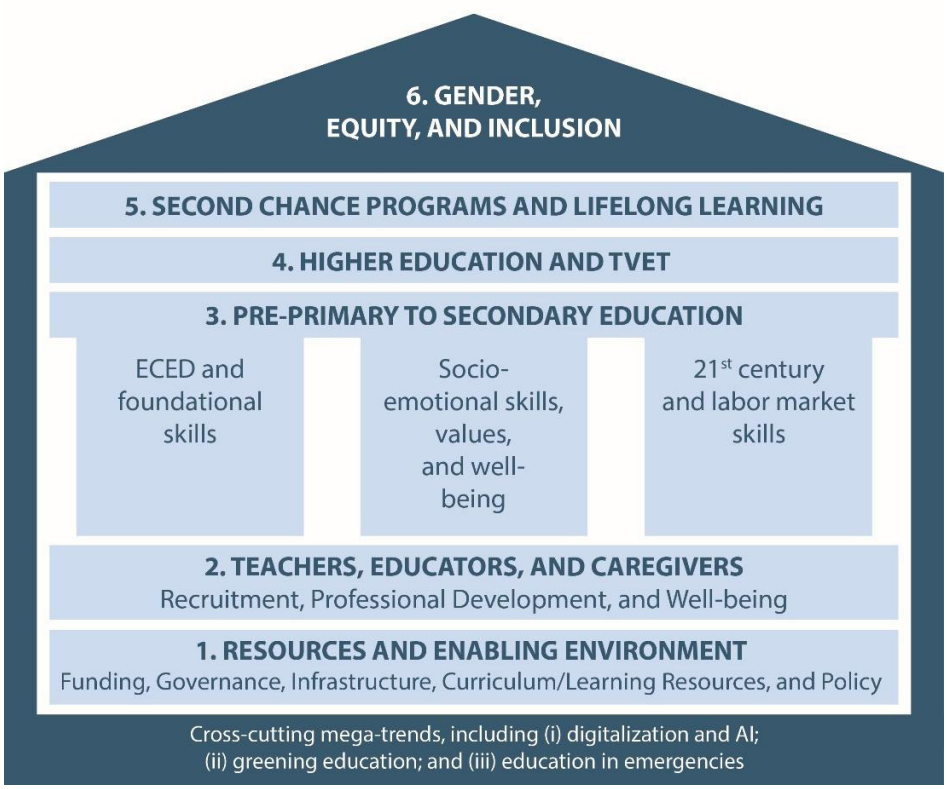
Introduction

Digitalization and artificial intelligence (AI) provide unique challenges and opportunities for African higher education, research, and innovation. The importance and limits of technology for improving educational outcomes were highlighted in the Global Education Monitoring Report on technology in education (UNESCO, 2023). These issues have also been discussed by the African Union Commission in a series of policies and frameworks to guide the work of Member States. Already a decade ago in the Continental Education Strategy for Africa or CESA 2016 to 2025 (African Union Commission, 2015), two of the twelve strategic objectives were about higher education and research and harnessing the capacity of Information and Communication Technologies (ICT). Additional guidance was provided by the African Union Commission (AUC) among others through its Digital Transformation Strategy for Africa 2020-2030 (African Union Commission, 2020a), a policy brief on digitizing teaching and learning in Africa prepared in response to the COVID-19 pandemic (African Union Commission, 2020b), and most recently in the Continental Artificial Intelligence Strategy (African Union Commission, 2024). One of the key initiatives from the AUC towards digitalization in higher education is the Pan African Virtual and E-University (PAVEU). The initiative was launched in 2019 as a Flagship Programme of Agenda 2063, the development blueprint of the African Union.

In this chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), the focus is on results from an online survey implemented to inform the African Union's new Continental Education Strategy for Africa 2026 to 2035 (CESA 26-35). The strategy was adopted by the African Union in February 2025 (African Union Commission, 2025b), following a review of the previous strategy (African Union Commission, 2025c). CESA 26-35 includes a brief investment case followed by a review of selected challenges. The core of the strategy is a framework for action with six strategic areas of focus. The last section of the strategy focuses on governance, communications, and data for monitoring and evaluation. Figure 1 visualizes key elements of the strategy, conveying the idea that education systems must be built, like a house or structure. The first two strategic areas are foundations, followed by three pillars combined into one strategic area emphasizing foundational, socio-emotional, and 21st century skills that learners must acquire in basic education. Next come educational opportunities through higher education and technical and vocational education and training (TVET) and programs for children and youth out of school as well as lifelong learning for adults. The roof and outside walls that encompass the whole system convey the importance of gender-transformative approaches, equity, and inclusion. Finally, the text at the base of the structure highlights critical mega-trends that education systems must adapt and respond to, including digitalization and AI.

4 The author is with UNESCO's International Institute for Capacity Building in Africa (IICBA). The opinions expressed in this article are those of the author only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA. This article is expanded from a note published in *Cloud*, the magazine of UNESCO's International Centre for Higher Education Innovation (ICHEI).

Figure 1: Framework for Action for CESA 26-35



Source: African Union Commission (2025b).

To convey prioritization, CESA 26-35 has 20 objectives, a smaller number than the 69 action areas in the previous strategy. For each objective, a brief discussion of its importance is provided together with guidance on promising interventions. Digital competencies and AI are mentioned in three different areas of CESA 26-35: (i) Higher Education and TVET is one of six areas of focus for CESA 26-35; (ii) Promoting 21st century and labor market skills, including for ICT/AI and STEAM, is one of three objectives for pre-primary to secondary education; and (iii) digitalization and AI are mentioned as one of three mega-trends that education systems in Africa must adapt to. Out of necessity, the discussion of these topics is limited in CESA 26-35 to keep the strategy at a readable length, but more detailed work could be conducted as part of CESA 26-35 implementation to flesh out the implications of digitalization and AI for (higher) education.

As part of work towards the adoption of CESA 26-35, a review of the experience with the existing CESA for the period 2016 to 2025 was conducted. As noted in the review (African Union Commission, 2025c), analysis was based among others on: (i) a review of relevant documents at the continental, regional, and country level, with a particular focus on documents from the AU; (ii) a review of the academic literature and the grey literature; (iii) inputs from discussions with individuals from target groups and AUC staff and leadership; and (iv) primary data collection through online surveys among various groups of stakeholders. Two of the online surveys were accessible only to pre-selected individuals (the survey for Ministries and RECs, and the survey for CESA cluster members). The other surveys were open to any respondents but targeted towards specific stakeholders through the dissemination mechanisms and organizations used to share the surveys. One of the online surveys focused on higher education, research, and innovation.

The CESA survey on higher education, research, and innovation included 30 questions. As part of the planning for this study[5], two questions were included on perceived constraints to digitalization and the use of AI (closed-form question) and on innovations to promote digitalization and the use of AI (open-ended question). The objective of this chapter is to share insights from these questions, with a focus on results from the closed form question[6]. Special thanks are due to staff from the African Union Commission for supporting the survey and organizations that helped for its dissemination, including the African Association of Universities, the African and Malagasy Council for Higher Education (*Conseil Africain et Malgache pour l'Enseignement Supérieur* in French or CAMES), Deutscher Akademischer Austauschdienst, the Flemish Interuniversity Council and Bureau UOS, and OBREAL (which initially stood for the Observatory on EU-Latin America Relations).

5 UNESCO-ICHEI has published a series of recent reports on digitalization in higher education. See the Institute's webpage on research at https://en.ichei.org/dist/index.html#/publicationDetail?nid=27&pid=8&cid=89.

6 Findings shared in this chapter are preliminary. A more detailed analysis of the survey will be available (Wodon, forthcoming), including responses to an open-ended follow-up question on innovations to promote digitalization and the use of AI in higher education, research, and innovation.

From a methodological point of view, the sample for the survey is relatively small at 741 respondents (180 in English and 561 in French – although in both languages, a few questions were not filled by all respondents). Given that the survey was administered online, there may be biases, for example with individuals connected to the internet more likely to respond. The sample and results may therefore not be representative of faculty and staff at HEIs across the continent. Still, the results of the survey are illustrative of perceptions regarding constraints to digitalization and the use of AI. The results seem fairly reasonable, and they are also coherent with findings from a separate, more detailed survey conducted specifically for this study (see Chapter 2) as well as findings from the case studies included in this study.

Constraints for Digitalization and the Use of AI

Using data from the CESA survey on higher education, research, and innovation, Table 1 and Figure 2 provide summary results from responses by respondents to the following question: *"In September 2022, the Transforming Education Summit called for various actions to improve education systems, including digitalization. There are also new opportunities from AI in higher education. On a scale of 1-5, how important are the following constraints to digitalization and the use of AI in higher education, research, and innovation in your institution or country?"* Respondents were asked to rate various potential constraints on a five-point Likert scale, as follows: (i) Not a constraint; (ii) Somewhat of a constraint; (iii) Average constraint; (iv) Important constraint; and (v) Very important constraint. The following constraints were listed: (1) Lack of infrastructure (e.g., insufficient internet, insufficient equipment, etc.); (2) Conservative academic culture; (3) Lack of funding opportunities; (4) Lack of technical support; (5) Lack of leadership and vision; (6) Management model of the institution too centralized or not promoting innovation; (7) Lack of collaboration among peers; (8) Unsatisfactory remuneration or incentives; (9) Faculty relatively old and not up to date with new techniques; (10) General lack of support of professional development; and (11) Other (please specify).

In Table 1, the number of English- and French-speaking respondents and their share rating the constraints at various level are provided, together with an aggregate rating computed in a simple way for ease of interpretation, i.e. a value of one is assigned for "not a constraint", two for "somewhat a constraint", three for "average constraint", and so on, so that average ratings take a value between one and five. The average ratings are visualized in Figure 2. As can be seen from Figure 2, responses are broadly similar among English- and French-speaking respondents, although English-speaking respondents tend to rate several of the constraints slightly more severely than French-speaking respondents.

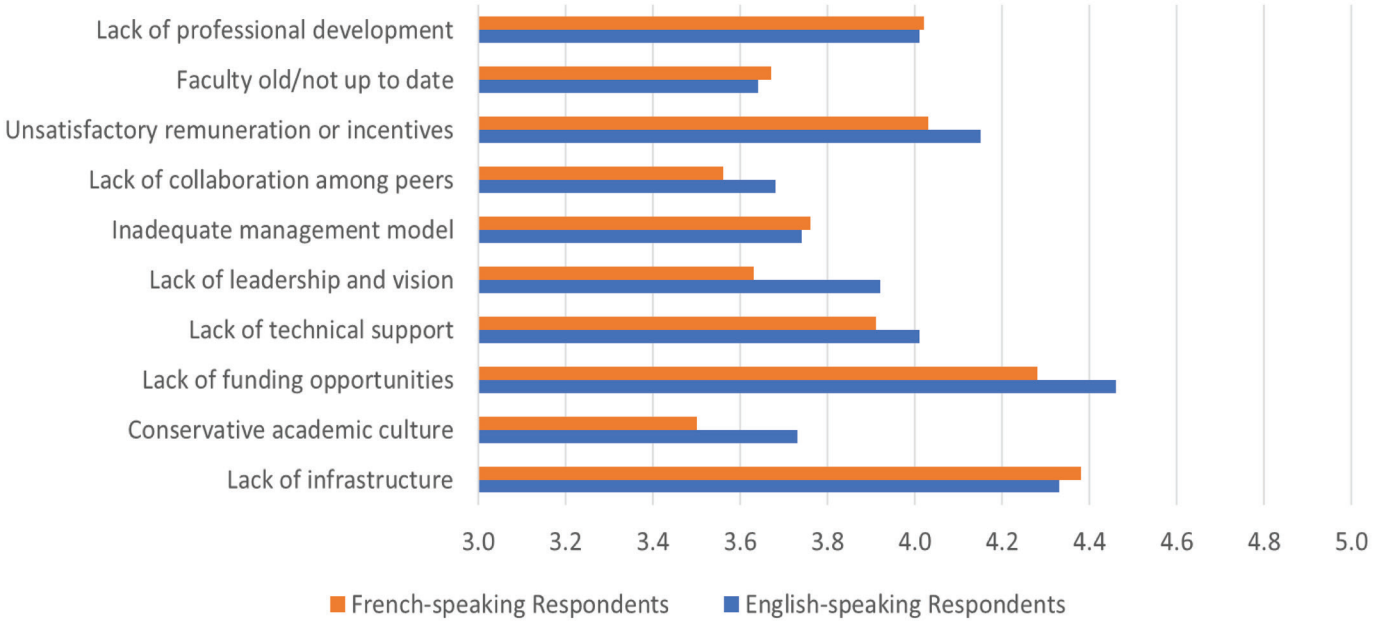
Table 1: Importance of Constraints to Digitalization and the Use of AI in Higher Education, Research, and Innovation in Your Institution or Country

	Not a Constraint		Somewhat of a constraint		Average constraint		Important constraint		Very important constraint		Total number	Weighted Average
	Share	Obs.	Share	Obs.	Share	Obs.	Share	Obs.	Share	Obs.	Obs.	Rating
English-speaking respondents												
Lack of infrastructure	2.4%	4	2.9%	5	12.9%	22	22.9%	39	58.8%	100	170	4.3
Conservative academic culture	7.1%	12	8.3%	14	20.1%	34	33.1%	56	31.4%	53	169	3.7
Lack of funding opportunities	0.6%	1	1.8%	3	9.0%	15	28.3%	47	60.2%	100	166	4.5
Lack of technical support	3.0%	5	4.2%	7	18.1%	30	38.0%	63	36.8%	61	166	4.0
Lack of leadership and vision	3.6%	6	9.0%	15	19.9%	33	27.1%	45	40.4%	67	166	3.9
Inadequate management model	6.0%	10	9.5%	16	21.4%	36	30.4%	51	32.7%	55	168	3.7
Lack of collaboration among peers	6.0%	10	10.1%	17	20.2%	34	37.5%	63	26.2%	44	168	3.7
Unsatisfactory remuneration or incentives	1.8%	3	6.6%	11	13.2%	22	31.7%	53	46.7%	78	167	4.2
Faculty relatively old/ not up to date	7.1%	12	11.8%	20	22.5%	38	27.2%	46	31.4%	53	169	3.6

Lack of professional development	0.0%	0	10.6%	18	14.7%	25	37.7%	64	37.1%	63	170	4.0
Other (please specify)											7	
French-speaking respondents												
Lack of infrastructure	1.0%	5	3.8%	20	8.3%	44	30.3%	160	56.6%	299	528	4.4
Conservative academic culture	5.0%	26	15.1%	79	25.7%	135	33.7%	177	20.6%	108	525	3.5
Lack of funding opportunities	0.6%	3	3.1%	16	11.5%	60	37.8%	197	47.0%	245	521	4.3
Lack of technical support	1.2%	6	7.7%	40	20.7%	108	40.2%	210	30.4%	159	523	3.9
Lack of leadership and vision	4.6%	24	13.8%	72	22.4%	117	32.1%	168	27.2%	142	523	3.6
Inadequate management model	3.2%	17	12.2%	64	21.0%	110	32.4%	170	31.2%	164	525	3.8
Lack of collaboration among peers	3.7%	19	14.7%	76	27.1%	140	31.3%	162	23.2%	120	517	3.6
Unsatisfactory remuneration or incentives	1.3%	7	8.6%	45	16.3%	85	32.8%	171	41.0%	214	522	4.0
Faculty relatively old/ not up to date	5.0%	26	12.0%	63	24.2%	127	29.0%	152	29.9%	157	525	3.7
Lack of professional development	1.9%	10	5.7%	30	17.5%	92	38.3%	201	36.6%	192	525	4.0
Other (please specify)											9	

Source: Author, from CESA survey on higher education.

Figure 2: Average Ratings of Constraints to Digitalization and the Use of AI (1 to 5)



Source: Author, from CESA survey on higher education.

A few key findings emerge from the data. First, the two most important constraints cited are the lack of funding opportunities and the lack of infrastructure, with both constraints likely related since the availability of infrastructure tends to depend on funding. Second, the next three most severe constraints are unsatisfactory remuneration or incentives, lack of professional development, and lack of technical support. Third, the other constraints, which tend to relate more to the management of higher education institutions and the culture prevailing in those institutions (conservative academic culture, lack of leadership and vision, inadequate management model, lack of collaboration

among peers, and faculty relatively old/not up to date) tend to be seen as less serious constraints. Fourth, while some constraints seem to be more important than others, all constraints have an average rating of at least 3.5, which suggests that all may play a role in limiting digitalization and the use of AI in African higher education.

Conclusion

Higher education institutions face challenges towards digitalization and the use of AI, especially in African countries characterized by constrained resources. This note shared preliminary findings on perceived constraints for digitalization and the use of AI among stakeholders who responded to an online survey implemented as part of data collection for a review of the African Union's CESA and the preparation of a new CESA. The two most important constraints cited by respondents were the lack of funding opportunities and infrastructure, with both constraints likely related since the availability of infrastructure depends on funding. The next three most severe constraints were unsatisfactory remuneration or incentives, lack of professional development, and lack of technical support. Other constraints related to the management of higher education institutions and cultural aspects were seen as less prominent. While the survey should not be considered as representative of higher education stakeholders in the continent, it points to the need to increase financial and technical support to African universities to enable them to reap the benefits from digitalization and the use of AI.

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Part II

Case Studies

Chapter 4

Digital Transformation in African Higher Education: Capacity Building through ICT Leadership and Universal Acceptance Adoption

Olusola B. Oyewole, Felicia Nkrumah Kuagbedzi, and Yaovi Atohoun[7]

Introduction

Across the globe, digital transformation is redefining higher education. It is reshaping how knowledge is created, shared, and assessed, and influencing everything from institutional management to student engagement. In Africa, this transformation holds tremendous promise for improving access, equity, and institutional resilience. Yet, realizing that promise is deeply complicated by entrenched structural and systemic barriers. The urgency to embrace digital tools and governance structures became especially apparent during the COVID-19 pandemic. The closure of campuses forced universities to turn abruptly to online learning platforms, exposing the sector's digital unpreparedness (Ajani, 2024). However, this moment of crisis also served as a catalyst: it challenged African higher education institutions (HEIs) to reconsider their infrastructure, leadership, policy frameworks, and pedagogical strategies for a digitally driven future (Maphalala and Ajani, 2023).

Amid this evolving context, digital transformation is no longer limited to the procurement of infrastructure or the introduction of e-learning platforms. Instead, it now demands deliberate strategy, institutional commitment, and—most critically—strong digital leadership. This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), begins by examining the current state of digitalization in African higher education and the persistent challenges that universities face. It then transitions into a focused scientific case study of a continental initiative led by the Association of African Universities (AAU), which targets the strategic empowerment of ICT leaders—specifically Directors of ICT (DICTs) and Chief Information Technology Officers.

Digitalization in African Higher Education

Before the COVID-19 pandemic, the digital landscape in African higher education was uneven and underdeveloped. Many institutions lacked robust ICT infrastructure, affordable internet access, and digital tools necessary to support large-scale online or blended learning environments (Paschal et al., 2020; Rutayisire et al., 2020). Learning Management Systems (LMS) were often underutilized, and digital libraries and research databases were available in only a limited number of universities, typically in better-resourced urban areas. Disparities in access between rural and urban institutions—and even within institutions—highlighted persistent digital divides. Many students entered university without basic digital skills, while lecturers lacked training in digital pedagogy (Maphalala and Ajani, 2023). In this environment, digitalization efforts were mostly fragmented pilot projects, rather than institution-wide strategies supported by policy or governance structures.

The COVID-19 pandemic served as both a shock and a wake-up call. It forced HEIs to deploy online learning platforms rapidly, often without preparation or stress testing, and exposed the lack of digital readiness at multiple levels. While some institutions adapted through partnerships, mobile-based learning, or temporary LMS expansion, others simply shut down due to the absence of digital alternatives (UNESCO, 2020; Bates, 2015). Beyond infrastructure, the pandemic spotlighted a deeper leadership gap. ICT decisions were often relegated to technical units without strategic alignment to institutional missions. As such, even where technology existed, the capacity to integrate it meaningfully into teaching, learning, and governance was limited. This highlighted the need for not just hardware and connectivity, but digital governance and leadership.

In many countries, regulatory frameworks for digital education were either non-existent or outdated. Accreditation bodies were often slow to recognize online courses, and institutions lacked policies on data protection, cybersecurity, and digital quality assurance (Ojo and Rodrigues, 2017). Institutional strategies, where they existed, often did

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not include sustainable plans for digital inclusion, mobile learning, or support for students with limited access to technology. Moreover, a lack of coordination between ICT units, academic departments, and senior leadership created implementation silos. The result was a failure to scale promising digital initiatives across the entire institution in that critical time of the pandemic.

Amidst these challenges, one theme emerged as central to all others: the need for informed, empowered, and strategically positioned ICT leadership. Institutions increasingly recognized that digital transformation cannot succeed without leaders who understand both the technical dimensions of ICT and the broader institutional vision. Directors of ICT (DICTs) and Chief Information Technology Officers (CITOs) were often underutilized in governance structures, yet they held the potential to be key change agents if given the right tools, training, and mandate. This realization set the stage for a new model of intervention—one that goes beyond infrastructure to invest in people, particularly those positioned at the nexus of technology and decision-making in the region.

Capacity Building and Strategic ICT Leadership

Recognizing the structural challenges facing African higher education, researchers and policy advocates have increasingly emphasized the importance of human capital development—particularly in the form of leadership—over purely technical solutions. The post-pandemic digital surge made one thing clear: infrastructure alone does not drive transformation. Instead, it is the ability of institutions to lead, plan, carry along their populace to accept change and govern their digital ecosystems that determines whether investments in technology translate into meaningful change.

In higher education environments, Directors of ICT (DICTs) and Chief Information Technology Officers (CITOs) occupy a critical—but often underleveraged—position. While traditionally viewed as technical managers, these professionals are uniquely placed at the crossroads of operational systems, academic delivery, data governance, and institutional planning. When strategically empowered, they can act as translators between technology and institutional missions, driving innovation, securing infrastructure investments, and aligning digital decisions with broader academic goals.

Prior to targeted interventions, many DICTs across African HEIs reported limited engagement in senior decision-making processes. ICT functions were treated as administrative services, rather than strategic assets. Without a voice in executive planning, DICTs struggled to advocate for budget allocations, long-term system architecture, or cybersecurity frameworks. As such, potential transformation efforts remained piecemeal or stalled altogether (Maphalala and Ajani, 2023; Ojo and Rodrigues, 2017).

The concept of capacity building in higher education refers not only to individual skill development but also to strengthening institutional systems and leadership cultures. Drawing on Bolman and Deal's (2017) organizational frames, effective capacity-building interventions must engage both the structural and human resource dimensions of institutions: that is, improving technical proficiency while enabling individuals to take initiative, lead reforms, and shape policy.

Training programs that combine digital governance, leadership communication, and cross-functional collaboration are particularly impactful in environments where institutional digital maturity is still evolving. This is especially true when programs are delivered regionally or continentally—where participants can learn from shared contexts, collaborate across borders, and build professional networks.

It is within this framework that the Association of African Universities (AAU)—Africa's premier higher education coordinating body—launched a strategic initiative to build the capacity of ICT leadership across the continent. Anchored in AAU's mandate to promote quality, access, and innovation, the initiative targeted DICTs, CITOs, and senior IT personnel from African universities with a dual purpose: (1) To equip them with strategic, governance, and policy skills needed to drive digital transformation in their institutions; and (2) To foster a cross-border community of practice capable of sharing tools, policies, and infrastructure models across institutions and regions.

In collaboration with the Internet Corporation for Assigned Names and Numbers (ICANN), the program was also designed to introduce and scale Universal Acceptance (UA) of Domain Names and Email addresses in university systems. UA ensures that all domain names and email addresses—regardless of language, script, or character length—function properly in digital environments. For African universities operating in multilingual settings and serving global audiences, UA compliance is a core requirement for digital inclusion and web interoperability. This combined emphasis on strategic ICT leadership and technical standards for inclusion marks the initiative as one of the most comprehensive continental responses to the digitalization gap in African higher education.

Case Study: The Association of African Universities' Initiative for ICT Directors

In response to the urgent need for strategic digital leadership in African higher education, the Association of African Universities (AAU) launched a coordinated capacity-building initiative targeting Directors of ICT (DICTs), Chief Information Technology Officers (CITOs), and senior IT project managers. This initiative, implemented from 2023, was designed to provide not only technical skills but also strategic governance competencies needed to lead institutional digital transformation. The group engaged in a series of continental workshops, technical collaborations, and thematic interventions that address key issues including digital infrastructure, governance, cybersecurity, and Universal Acceptance (UA).

The initiative has been further bolstered by a collaboration with ICANN and the Coalition for Digital Africa. This partnership brought UA adoption into focus—a crucial yet often overlooked dimension of digital inclusion in African contexts. The following subsections present the methodology, outcomes, and institutional shifts achieved through this intervention.

This case study adopts a qualitative descriptive research design, guided by the methodological framework of Yin (2018). Data were drawn from multiple sources to ensure triangulation and depth of insight. Primary materials included workshop reports from the Association of African Universities' ICT leadership events held between April 2023 and February 2024 in Accra (Ghana), Windhoek (Namibia), and Rabat (Morocco). In addition to these, data on Universal Acceptance (UA) compliance by African universities was collected under the AAU's initiative with ICANN, offering a baseline and follow-up assessment of institutional digital readiness across the continent.

Further, qualitative input was obtained through participant feedback gathered via structured surveys and focus group discussions conducted at the close of each workshop. These reflections captured individual experiences, institutional intentions, and perceived barriers to implementation. Supplementary data included institutional implementation reports submitted by workshop participants, detailing post-training activities, governance reforms, and system upgrades.

The study engaged over 95 ICT leaders from more than 50 African universities, with the broader scope of UA assessments and technical outreach covering more than 400 higher education institutions across the continent. Thematic analysis was employed to interpret the collected data, with particular focus on patterns related to IT governance practices, strategic alignment of digital systems, digital inclusion efforts, and emerging regional collaborations.

Key Results

Capacity Building through Continental Workshops. The workshops covered seven core modules: AI leadership, IT governance frameworks, cybersecurity, cloud services, ERP implementation, communication strategy, and professional development. These sessions were delivered in English and French—to ensure accessibility and regional inclusiveness to the registered participants of the capacity building initiatives. Participants reported substantial improvements in their ability to: Design and communicate institutional IT strategies; Justify and manage ERP procurement and implementation; Establish IT steering committees and governance dashboards; and Translate technical insights into actionable policy recommendations. The multilingual nature and peer-to-peer engagement fostered a collaborative learning environment where institutions could benchmark practices and adopt common frameworks.

Strategic Governance and Cybersecurity Improvements. A major outcome was the institutionalization of IT governance practices. Participants returned to their institutions and initiated: Creation of formal IT governance charters; Establishment of cybersecurity task forces; Integration of access control policies and data protection clauses for third-party vendors. Many institutions developed IT strategic plans aligned with university development goals. This marked a shift from reactive ICT management to strategic oversight.

Universal Acceptance Adoption. Working with ICANN, the AAU conducted baseline UA readiness assessments across over 400 African universities. As of April 2023, only 88 websites and 227 email systems were UA-compliant. By August 2024, following: Technical workshops; One-on-one university engagements; and Curriculum integration pilots, UA compliance improved to 305 universities. Benefits reported included improved email delivery across platforms, enhanced global web presence, and the ability to support email addresses in local languages and scripts. Technical improvements were also contributed back to platforms like WordPress, reinforcing global UA awareness. Aside from the engagement with the ICT directors, the UA initiative also focuses on UA models integration into university curricula and therefore involves vice chancellors and lecturers.

Institutional Collaboration and Regional Planning. The workshops also gave rise to new continental networks of ICT leaders. Participants began: Coordinating software license negotiations across institutions; Planning shared infrastructure investments (e.g., hosting, cloud services); Exploring co-developed ICT policy templates and digital curriculum resources. These efforts laid the groundwork for a pan-African community of practice in ICT leadership and digital governance.

Discussion

The case study of AAU's ICT Directors' initiative illustrates the critical importance of targeted leadership development in advancing digital transformation within African higher education institutions. While much of the discourse around digitalization in Africa tends to focus on infrastructural deficits, this case reveals that institutional capacity — particularly in leadership and governance — is equally, if not more, decisive in determining whether digital technologies translate into meaningful change.

Leadership as a Missing Link in African Digital Transformation. Prior to the AAU-led intervention, ICT leadership in many African universities were in some instances disconnected from senior institutional strategy. DICTs and CITOs operated as service managers rather than strategic partners in some institutions. Consequently, decisions around infrastructure procurement, software integration, and data governance were made in silos, often without long-term vision or cross-departmental alignment (Maphalala and Ajani, 2023; Ojo and Rodrigues, 2017). The AAU program has demonstrated that this disconnect can be addressed through targeted, regionally contextualized training that empowers ICT leaders to influence policy, communicate with executive teams, and manage digital portfolios with strategic foresight. Participants in the program not only acquired technical knowledge but also demonstrated immediate shifts in behaviors and institutional practice. The introduction of IT governance dashboards, cybersecurity protocols, and ERP frameworks aligned with institutional goals points to a broader cultural shift: one in which ICT units are increasingly viewed as strategic enablers of academic excellence, research visibility, and administrative efficiency.

Universal Acceptance as a Vector for Digital Inclusion. The integration of Universal Acceptance (UA) into the AAU initiative adds a distinct layer of value, addressing a key aspect of digital inclusion that is often overlooked. While broadband access, internet connectivity and device availability are critical, true inclusion requires that all languages, scripts, and character sets are equally supported across digital systems (ICANN, 2024). In the African context—with its vast linguistic diversity—UA compliance is essential for ensuring that students, faculty, and administrators can participate in the digital ecosystem using locally meaningful identifiers. The measurable increase in UA compliance—from 227 to 305 institutions—demonstrates that progress is possible when standards are backed by training, technical support, and policy alignment. Furthermore, by contributing code and feedback to global platforms like WordPress, African institutions are not only adapting to global standards—they are shaping them.

Regional Collaboration as a Force Multiplier. One of the most compelling outcomes of the initiative is the emergence of regional collaboration platforms among participating institutions. These informal networks—focused on shared licensing, joint procurement, and co-developed curricula—address one of the long-standing inefficiencies in African HEIs: duplication of effort and resource fragmentation. By coordinating across borders, institutions can reduce costs, negotiate better terms with vendors, and standardize quality benchmarks. This regionalization of ICT strategy mirrors successful models seen in other sectors (e.g., health, telecommunications) and signals a growing maturity in the governance of digital education across the continent.

Comparing Global Models and Local Strengths. When viewed alongside digital transformation efforts in Europe, North America, or parts of Asia, the AAU's model is distinctive in several ways: It is multilingual, catering to Africa's diverse linguistic zones. It is context-sensitive, addressing governance and infrastructure simultaneously. It builds local leadership rather than relying solely on external expertise. And it integrates policy-level engagement through partnerships with organizations like ICANN. These features make the model particularly suited for replication across similarly resource-constrained or multilingual environments. However, challenges remain—most notably: Sustaining post-training momentum at institutional level; Ensuring national policy frameworks catch up with institutional innovation; and Expanding the reach of such interventions beyond early adopters.

Conclusion

The AAU's initiative to empower Directors of ICT and Chief Information Technology Officers across African universities offers a powerful model for how such transformation can be achieved. Equipping ICT leaders with the tools to manage governance, cybersecurity, ERP systems, and institutional strategy, has shown to catalyse meaningful shifts in how universities approach digital change. The integration of Universal Acceptance further strengthens the initiative's contribution to digital inclusion, ensuring that Africa's linguistic and cultural diversity is reflected and supported in its digital infrastructure.

The initiative's success lies in its continent-wide scope, multilingual delivery, and combination of technical and strategic training. It also demonstrates the value of collaboration—between universities, development organizations like ICANN, and regional higher education bodies—in overcoming common barriers through shared learning and mutual support. However, sustaining this momentum requires continued effort. Policy frameworks must evolve to support digitally inclusive practices, institutional leaders must prioritize the strategic integration of ICT into all domains of university life, and investment in human capital must remain a central pillar of digital planning. Regional cooperation, resource pooling, and performance monitoring will be key to scaling the model beyond early adopters.

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Chapter 5

The Pan-African Virtual and E-University (PAVEU): Transforming Access to Higher Education Across Africa

Bolanle Akeredolu-Ale[8]

Introduction

As part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), this chapter provides a case study of the Pan African University (PAU), an initiative from the African Union Commission's (AUC) to rejuvenate higher education and research in Africa under the auspices of the Second Decade of Education for Africa and the unified Plan of Action of Science and Technology for Africa. PAU is set to embody excellence and boost the appeal and global competitiveness of African higher education and research, positioning the African University at the heart of Africa's progress. The university was created to bring together regional centers of excellence across Africa. As a flagship African Union initiative, it fosters postgraduate education with a focus on cutting-edge research and regional development. Yet, despite success in advancing postgraduate training and research, the need to reach more learners – especially those in remote or underserved areas – called for a digital evolution. This vision materialized in the form of the Pan African Virtual and E-University (PAVEU).

PAVEU is both an innovation and an imperative. As a flagship initiative under Agenda 2063, it aims to overcome barriers of geography, infrastructure, and accessibility through a comprehensive virtual learning platform. It seeks to democratize education, elevate the role of research in policymaking, and nurture a skilled, entrepreneurial workforce capable of driving Africa's transformation. Since its inception, PAVeU has positioned itself as a critical driver in expanding Africa's human capital through digital transformation. It acts as both a knowledge platform and a strategic enabler for achieving Africa's aspirations for inclusive growth, sustainable development, and socio-economic transformation.

While PAU was established in December 2011, PAVEU was launched eight years later, in December 2019 by H.E. Pr. Jacques Fame Ndongo, the Minister of State, Minister of Higher Education of the Republic of Cameroon, under the esteemed patronage of the President, H.E. Paul Biya, at the Palais des Congrès of Yaoundé. The event was co-organized by the Department of Education, Science, Technology and Innovation (ESTI) of the African Union Commission (AUC), and the government of the Republic of Cameroon. The launch was aimed at publicizing and promoting PAVEU, discussing potential implementation challenges, and exploring its contribution to the academic and research landscape of the African University, as well as its potential in fulfilling the aspirations of the African Union's Agenda 2063.

The establishment of PAVEU marked a turning point in PAU's evolution by integrating digital learning into the university's broader strategy. The vision of PAVEU is to become a leading African center of excellence for open, inclusive, and accessible online postgraduate education and research that supports the continent's social, political, and economic transformation. Its mission is to provide world-class, inclusive, and quality-assured digital education to African learners anytime and anywhere, while supporting innovative research aligned with the African Union's Agenda 2063. In terms of core objectives, PAVEU aims to: (i) Expand access to postgraduate and lifelong learning opportunities across the continent; (ii) Strengthen Africa's human capital base, especially in science, technology, and innovation; (iii) Develop research and education programs that are relevant to Africa's development priorities; (iv) Support evidence-informed policymaking and governance through research translation.

Institutional Framework

PAVEU is hosted by PAU, whose network is currently composed of four Institutes spread across the continent's regions, each addressing specific aspects of the Agenda 2063: (1) The Pan-African University Institute of Water and Energy Sciences including Climate Change (PAUWES), in Tlemcen in Algeria, provides Master's degree programs in energy engineering and policy, water engineering and policy, and climate engineering and policy; (2) The Pan-African University of Life and Earth Sciences (PAULESI), in Ibadan in Nigeria, offers nine Master's programs in agriculture, Geosciences and Environmental Management; (3) The Pan-African University Institute of Science, Technology and Innovation (PAUSTI), located in Nairobi, Kenya, offers nine Master's and seven PhD courses in basic sciences, mathematics, and innovation; (4)

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The Pan-African University Institute of Governance, Humanities and Social Sciences (PAUGHSS), located in Yaoundé in Cameroon, provides four Master's and one PhD. An additional Institute is planned in South Africa.

Together, as of the time of writing this article, PAU's Institutes have trained nearly 2,000 postgraduate students in key development areas. However, physical limitations restrict their capacity to meet the exponential demand for quality higher education. PAVEU was therefore conceptualized as the digital arm of the PAU, enabling it to serve thousands more through a flexible, inclusive, and scalable platform. PAVEU aligns with multiple AU strategic objectives: (i) Strengthening the knowledge economy; (ii) Expanding access to quality education; (iii) Promoting innovation and entrepreneurship; and (iv) Fostering regional integration and collaboration.

Examples of Programs and Initiatives

Prior to the launch of PAVEU, a call for application was issued for three available courses. Three partners agreed to provide one course each, accessible via the PAVEU online learning platform. This decision was made during a PAVEU Experts meeting held in Yaoundé, taking into account that PAVEU did not have any course program ready for the launch. This was intended to be a temporary measure. Prior to its launch, three pilot courses were introduced with the help of external partners: (1) Cloud and Virtualization Concepts (753 registered students); (2) Media and Information Literacy (775 registered students); and (3) Skills for Employability (1,229 registered students).

As an example of a more recent initiative, consider the Pan-African Health Information, Resources and Training Partnership (PAHIRTP) with UNESCO. This initiative offers an online capacity building and training program on media information literacy and pandemics, using COVID-19 as a case study. This six-month certified program builds on the following courses: an «online fact-checking course» co-developed and delivered with AfricaCheck, a health science communication module delivered with ISAAA AfriCenter, and a media and information literacy course co-developed with UNESCO, all of which aim to strengthen public health communication and digital literacy among media professionals and students across Africa.

Another initiative is the mini-grid digitalization and entrepreneurship (PAU MDE) developed with PAUWES and funded by the Department for International Development (DFID). This one-year online program aims to build technical and entrepreneurial capacity in Africa's energy sector with a focus on: (1) Smart micro-grid technologies; (2) Renewable energy; and (3) Entrepreneurship and business incubation. Still another initiative is an online course on internet governance under the auspices of the Policy and Regulation Initiative for Digital Africa (PRIDA). The African Union Commission on Energy and Infrastructure partnered with PAVEU to design and roll out this asynchronous virtual course as part of technical assistance provided by PRIDA, a collaborative effort of the African Union, the European Union, and the International Telecommunication Union to empower Africa to leverage digitalization by addressing various aspects of broadband demand and supply and enhancing internet governance capacities in Member States. The course, Internet Governance, was developed to help policymakers and stakeholders navigate digital transformation and broadband policy. Finally, another initiative is an online entrepreneurship course developed with the United Nations Office for South-South Cooperation (UNOSSC), promoting self-employment, business creation, and innovation.

In terms of current programs, considering that 2024 was the Year of Education in Africa, PAVEU launched a professional development course for primary and secondary school teachers in Africa, to train them in designing digital curricula. The project is being implemented by the Center of Excellence International Consultancy based in Addis Ababa, Ethiopia. The curriculum and syllabuses for teacher training have been designed. Thereafter, online courses were developed into downloadable training handbooks containing the core elements of the training. The project is at the point of publishing the course on PAVeU MOODLE platform. In addition, PAU through PAVEU is collaborating with UNESCO IICBA on a joint project titled, *"Empowering Female Teachers and School Leaders in Crisis Situations through Integrating Mobile-based Learning in the PAVEU Initiative."* The initiative seeks to empower female teachers and school leaders operating in crisis-affected areas. Through the integration of mobile-based learning, the project aims to provide quality, accessible, and flexible professional development opportunities. Target regions include the five PAU host countries (Kenya, Nigeria, Algeria, and Cameroon) as hubs, alongside South Sudan. In partnership with a Japanese EdTech firm, and supported by the Government of Japan, the initiative aligns with Africa's broader goals for inclusive, gender-responsive, and technology-enabled education.

Strategic Plan, Challenges, and Opportunities

PAVEU aims to raise awareness and strengthen capacity for the implementation of Agenda 2063. Courses on topics such as the Continental Free Trade Agreement will be developed and offered. In addition, courses on the History of Africa and Gender will also be offered online. At a strategic level, PAVEU's plan for 2024-2026 envisions scaling operations and

impact across the following core areas. Twelve master's programs from the four PAU Institutes (three per Institute) will be digitalized by 2028. Each Master's program will admit 100 participants, with candidates hailing from all regions of the continent. With twenty-four cohorts, this would lead to a target of 2400 participants. The design and delivery of the programs will be carried out incrementally, with four programs (one per Institute) digitalized per year.

The online programs will concentrate on policy issues, targeting practitioners from policy institutions at the national, regional, and pan-African levels. The aim will be to enhance competencies among practitioners and institutions. Topics will include frontier technologies and skills for innovation and employability in the African context, building among others on the delivery of the online program on mini-grid digitalization and entrepreneurship mentioned earlier. Other programs to be digitalized will cover topics such as artificial intelligence and its application in Africa to be developed with AIMS, climate innovations and entrepreneurship to be offered with WASCAL or SASSCAL, and digitalization jointly with other partners such as the United Nations University Network. More broadly, PAVEU will also develop new programs to address the specific needs of the AUC, including self-paced courses, massive online courses (MOOCs), and tutored or certified courses and programs. The programs will be developed to serve both traditional students and mid-career professionals. In so doing, PAVEU will work with strategic partners including the African Development Bank, while making sure that PAVEU's digital learning strategy is aligned with three core objectives of Agenda 2063: (1) Transformative Education: Enhancing human capital through skills development and professional training; (2) Innovation and Knowledge Economy: Supporting research, policy, and entrepreneurship across sectors; and (3) Regional Integration: Enabling cross-border education and collaboration among AU member states.

Despite progress, PAVEU faces challenges that must be addressed for it to reach its full potential. These challenges are not unique to PAVEU but are emblematic of broader systemic issues that confront digital higher education across Africa. They include the following constraints:

- Human Resource Gaps. Unlike traditional universities that rely heavily on subject-matter expertise, virtual institutions must also employ a robust cadre of instructional designers, digital pedagogues, multimedia specialists, learning technologists, and platform administrators. One of the most pressing constraints is the lack of experienced personnel with the specialized skills required to design, implement, and sustain high-quality e-learning programs.
- Technical Support and Infrastructure Constraints. While PAVEU has begun to establish the core components of its digital learning infrastructure, its internal capacity to manage, upgrade, and maintain these systems remains limited. Maintaining a Learning Management System (LMS) like Moodle requires a dedicated team for server administration, user support, data security, and regular platform updates. Improving access especially in rural and remote areas faces bandwidth limitations, electricity instability, and hardware incompatibilities that degrade the learning experience. In addition, cloud integration, cybersecurity protocols, and data management systems are underdeveloped or inconsistently applied across programs. These challenges expose the institution to potential downtime, data breaches, and learner dissatisfaction, particularly during peak periods or assessments.
- Communication and Coordination Gaps. As a digital institution that spans all five regions of Africa, PAVEU must coordinate an intricate web of actors – faculty from the PAU Institutes, tutors, instructional designers, national education authorities, development partners, and thousands of learners. Coordination between PAVEU and the four physical PAU institutes is still evolving.
- Financial Sustainability and Institutional Ownership. Perhaps the most existential challenge for PAVEU is securing long-term financial sustainability. To date, much of its funding has come from AU budgets and strategic partnerships. While such support has been instrumental in laying the foundation, it is not guaranteed to continue indefinitely. Without institutional mainstreaming into the AU system – including permanent staff positions, budget lines, and inter-departmental alignment – PAVEU risks being seen as a peripheral project rather than a core function of the African Union's education and development strategy.

There are also opportunities. By leveraging its virtual infrastructure, multilingual capabilities, and cross-sectoral partnerships, PAVEU can extend educational opportunities to all 56 African Union Member States. Its geographic neutrality and mandate give it a strategic advantage over national or regional online universities. There is potential for PAU to serve as a pan-African knowledge repository, a conduit for cross-border research and academic collaboration, and a platform for regional integration through harmonized qualifications, shared resources, and common policy training programs. Beyond delivering academic content, PAVEU is well-positioned to serve as a continental innovation hub, incubating new forms of digital research dissemination, policy engagement, and entrepreneurship ecosystems. Finally, Africa's youth bulge presents both a challenge and an economic opportunity. By targeting youth and mid-career professionals, PAVeU can contribute to closing the skills gap, enhancing employability, boosting job creation, and

supporting public sector transformation. In this respect, apart from traditional graduate degrees, areas for potential investment include: (1) Expanding reach through micro-credentials; (2) Developing short, modular courses aligned with emerging job market needs; and (3) Offering certification that can feed into full master's programs or be used independently.

Conclusion

PAVEU represents a bold, necessary, and potentially transformative response to the education and development challenges facing Africa. As a flagship initiative of Agenda 2063, it demonstrates how digital innovation can catalyze social equity, inclusive growth, and sustainable development. By combining policy-relevant education, scalable delivery models, and continental collaboration, PAVeU aims not only to expand access to higher education but also reshape its future in ways that are African-led, globally competitive, and digitally inclusive. The journey ahead requires unwavering commitment, robust systems, and strategic foresight – but the foundation is strong. It is our firm belief that PAVeU has the potential to achieve significant impact and amplify the impact of the PAU in several domains. As a pioneering initiative within the AU's Agenda 2063, PAVEU's early successes and setbacks offer valuable insights not only for its future trajectory but also for other emerging digital higher education platforms across the continent. The following key lessons, derived from internal evaluations, pilot experiences, and partner feedback, highlight the core elements required for sustainable and scalable e-learning in Africa.

First, institutional capacity matters. One of the most consistent and vital takeaways from PAVEU's journey is that digital education is only as strong as the institutional ecosystem that supports it. Technology can enable scale, but without the right human capacity and systems, it cannot ensure quality or sustainability. At PAVEU, the need for qualified personnel has been particularly acute in areas such as instructional design, platform management and system administration, content curation, and learner support and tutoring. Thus, a major institutional lesson is that investing in dedicated teams for e-learning is not optional but foundational. Capacity-building must be seen not as a one-off training event, but as an ongoing professional development ecosystem, ideally supported by a continental talent pipeline.

Second, strategic partnerships are key. PAVEU would not have achieved its current momentum without a wide array of strategic partnerships – each contributing resources, knowledge, and legitimacy. These collaborations have not only enabled rapid deployment of pilot programs but have also mitigated resource gaps in critical phases of institutional development. These partnerships were instrumental not only for course delivery but also for shaping PAVEU's strategic orientation, ensuring relevance to African development priorities, international best practices, and cross-sectoral synergies. Equally important is the lesson that partnerships must be structured and mutually accountable. Clear roles, deliverables, and sustainability plans must be outlined from the outset. PAVEU's experience has shown that informal or loosely defined collaborations can falter over time, particularly when funding cycles or personnel change. Going forward, institutionalizing a partnership management framework that aligns external collaboration with PAVEU's academic and operational needs will be essential for consistent growth.

Third, flexibility and accessibility drive participation. A defining strength of PAVEU's approach has been its commitment to flexibility and accessibility – the cornerstones of learner-centred education in the digital era. This commitment has been critical to increasing enrolment, especially among learners from rural areas, women, and working professionals. Furthermore, PAVEU learned that learner success is not merely a function of access, but also of engagement and support. The most successful courses combined flexibility with optional real-time check-ins, peer forums, and quick-response tutor support. Essentially, digital inclusivity is about more than connectivity – it is about designing systems around the realities of African learners, many of whom are mobile-first, cost-sensitive, and navigating multiple roles in society.

In terms of future outlook, as Africa stands at the intersection of a digital revolution and a demographic boom, PAVEU is uniquely poised to shape the future of higher education on the continent. It offers a blueprint for addressing some of the continent's most urgent developmental priorities, from youth employment and public sector capacity to entrepreneurship and scientific research. Looking ahead, opportunities and strategic directions should emerge for PAVeU to expand its impact.

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While the chapter does not include formal citations, it relies on a series of internal documents available from the author. The reference to the broader study, of which this chapter is part of, is [LT2] Wodon, Q., Editor (2025). *Digitalization and the Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study*. Addis Ababa, Ethiopia, and Shenzhen, China: UNESCO IICBA and UNESCO-ICHEI.

Chapter 6

Open and Distance Learning and Challenges of Artificial Intelligence: Keys to Success for the Innovative Pedagogical Model of the Université Virtuelle de Côte D'ivoire

Fernand Koffi Kouamé, Tiémoman Koné and Cécile Coulibaly[9]

Introduction

Today, Africa remains a continent of opportunities, with the youngest population on the planet, a capacity for innovation not yet been fully explored, and sustained economic growth. Indeed, with 70 percent of the population under the age of 30, youth is one of the continent's main assets and represents an important human capital that should be a major driver of economic development, social cohesion, and lasting peace (Koné, 2024). However, in recent years, higher education has been facing strong pressure from an increasing student population, as well as the need for social inclusion. To meet these challenges, distance and online learning is becoming an essential strategic lever, particularly in developing countries (AUC, 2015; UNESCO, 2023). Through digital technology and its uses, as well as investment in the creation of virtual universities which are much less costly than traditional universities and provide flexibility for learners, the development of industry 4.0 can enable Africa to substantially improve the rate of citizen access to higher education, a key to expanding the knowledge society and development (Koné, 2024).

Digitalization in higher education can be considered as part of Agenda 2063, the African Union's platform adopted in 2013 which places particular emphasis on investing in human and social capital through the education and skills revolution, with a focus on innovation, science and technology. One of the flagship projects is the creation of an African virtual and electronic university to improve access to higher education and continuing education using information and communication technologies (AUC, 2015; Puimatto, 2017; AUF, 2024). UNESCO (2022a; 2022b) in recent recommendations stresses the importance of integrating digital skills, artificial intelligence (AI) tools, and the principles of ethics, inclusion and accessibility into educational schemes. Indeed, by dedicating the International Day of Education 2025 to AI, UNESCO is aiming for a global discussion on the place of this technology within education (Azoulay, 2025).

As part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), this chapter is a case study about the experience of the Université Virtuelle de Côte d'Ivoire (UVCI). Since 2009, Côte d'Ivoire has been committed to the Baccalaureate-Master-PhD (LMD in French) system, a major reform of the higher education sector aimed at modernizing and rehabilitating public universities and prestigious colleges, developing a harmonized training system geared towards professionalization, semester-based courses and academic mobility, and above all integrating ICT into the teaching, learning and research system. UVCI was created in 2015 as a strategic response to the LMD reform to extend access to higher education anywhere and anytime, based on digital technologies. Its main mission is fully in line with the Sustainable Development Goals (SDGs), in particular SDG4, which aims to ensure inclusive, equitable and quality education (UNESCO, 2023). It also supports Ivorian and African face-to-face universities in improving governance through dedicated digital platforms and transforming pedagogical practices (Puimatto, 2017; UVCI, 2018). With its complex beginnings due to the general public's unfamiliarity with this new form of education in a landscape hitherto dominated by physical establishments, UVCI is the culmination of a long process (Koné, 2024). Its success is an example of change management and resilience in an environment such as higher education, considered sometimes to be conservative and hostile to change.

The accelerated development of AI is profoundly transforming society and educational models, particularly distance learning. By creating a UNESCO Chair in Artificial Intelligence, Humanity and Open Science, UVCI is engaging in critical reflection and action (education, awareness-raising, research) on issues of ethics, equity, governance and inclusion. Through this case study, UVCI shares its experience on the conditions for operationalizing its online and distance learning model, its constraints, its technological choices, and the prospects it is charting in the AI era.

9 The authors are with the Université Virtuelle de Côte d'Ivoire

Challenges and Achievements

UVCI was created in 2015 against a backdrop of reform of the higher education system and, above all, the promotion of information and communication technologies to improve access to higher education and continuing education. The «*Support for the creation of the Université Virtuelle de Côte d'Ivoire*» project was part of the AMRUGE-CI project*:* «*Appui à la modernisation et à la réforme des universités et grandes écoles de Côte d'Ivoire*», initiated under the *Contrat de Désendettement et de Développement* (C2D) with technical and financial support from international partners such as *Agence Française de Développement (AFD) and Agence Universitaire de la Francophonie (AUF)*. Through this support, in a landscape dominated by face-to-face training, UVCI has become a pioneering digital institution, positioning itself as a leader in digital technology and the promotion of virtual environments for both teaching and research.

This has been achieved among others through the development of: (1) Digital spaces for accessing scientific and technical information in addition to library books and journals, courses for small groups, training sessions, collaborative work by "formation ouverte et à distance" (FOAD, *open and distance learning*); (2) Studios for recording and editing educational videos for MOOC production, educational videos for open and distance learning (ODL), university promotion and communication; (3) Innovative third places (fablabs and incubators) for prototyping, digital factories, promotion of business ideas and young entrepreneurship; (4) Support for faculty-researchers in the pedagogical scripting and mediatization of course content and online practical work; in the production of pedagogical videos and studio teasers; in leading and tutoring learners enrolled in MOOCs; in learning how to put content online on an Open EdX platform; in supporting faculty-researchers in putting courses online during pedagogical continuity; and (5) MOOC, ODL expertise, etc...

Thanks to the AMRUGE-CI project, UVCI has gone from a concept (decree n°2015-775 of December 9, 2015) to an operational reality as of 2017, with the development of solid technical and technological infrastructures, trained teachers and tutors and teaching resources disseminated on digital platforms (Moodle, Edx), and welcoming its first 5,000 state-oriented baccalaureate holders. This first cohort benefited from tablet kits with SIM cards to compensate for the Internet access difficulties of a large proportion of learners, facilitating nomadic and flexible access to training.

As in many African countries, access to a stable Internet connection is uneven in Côte d'Ivoire, especially in rural areas. Despite progress, the digital divide remains a major obstacle. However, the environment and conditions of telephony penetration have been taken into account in the development of UVCI's innovative training scheme. As Koné (2024) points out, *"in view of the expansion of the smartphone in society and particularly among young people, which is greater than the penetration of the laptop, the pedagogical model developed was based on the smartphone".* As mobile internet is not always available everywhere despite the efforts of the authorities, the choice of the smartphone-based scheme means that learners can download courses onto their cell phones for consultation at any time. With the vast rural electrification program launched by the Ivorian government, it is now rare to find a densely populated rural locality in Côte d'Ivoire without electricity. Learners can therefore stay in their villages to follow their courses at UVCI, hence the slogan: "*My university, with me everywhere, at all times*". With its hybrid infrastructures, MOOCs, studios, incubators, fablabs, immersive labs and strategic partnerships, UVCI embodies a pivotal model for digital transformation in French-speaking Africa.

According to UNESCO*, "African education systems must invest in the training of teachers and technical staff to ensure the sustainability of digital devices"* (UNESCO, 2023). Mastery of digital tools, pedagogical design adapted to the online format, and learner support are major challenges. UVCI has developed expertise in training and capacity-building for teachers in digital pedagogy. This marks a decisive turning point in the reform of the LMD system, based on the integration of ICT into teaching and emphasizing the principles of *"learning differently, teaching differently and assessing differently"* in the digital age.

Over the years, UVCI has built up its offer around initial, continuing and certification training courses, covering a wide range of courses in IT and Digital Applications, such as databases, application development, IT security, multimedia, digital communication, digital marketing, E-administration, blockchains, geospatial sciences and technologies, artificial intelligence, high-performance computing and mathematics. More recently, several other specialties covering digital humanities and societies, as well as digital management and economics, have been developed. UVCI also plays a federating role in French-speaking universities, notably through the co-founding of the *Réseau Francophone des Universités Virtuelles* (RéFUV) and the signing of framework agreements with international partners, including UNESCO-

ICHEI, the Conseil Africain et Malgache pour l'Enseignement Supérieur (CAMES, *African and Malagasy Council for Higher Education*), CISCO, the Institut de Recherche pour le Développement (IRD-France, *French National Research Institute for Sustainable Development*), etc.

Today, UVCI has deployed a complete distance learning demonstrator, built around an innovative model that combines digital infrastructures, social inclusion and pedagogy adapted to local contexts. The development of the system was based on a clear vision: *"To be the sub-regional leader in digital education by modernizing and improving the quality of higher education provision, research and scientific innovation".* This vision is an operationalization of Côte d'Ivoire's National Development Programs (NDP 2016-2020 and 2021-2025), improving the rate of access to quality higher education and increasing the potential for quality human resources and wealth creation, one of the levers for the country's emergence.

To implement this vision, a strategy for the promotion and development of digital technology based on local realities was deployed and made operational by the UVCI project management team. This strategy was built on a number of practical elements and provisions, the central point of which is the commitment of the "taskforce" governance team to innovation and change management in all sectors, through the digitization of procedures involved in UVCI's four processes: i) training; ii) employability; iii) research; iv) and digital humanities. A number of platforms have been designed to meet the needs of teaching, technical and administrative staff, learners and parents of learners for most of the university's services (campus, schooling, administration, pedagogy, logistics, infrastructure, etc.) Commitment to change and innovation has enabled this transformation to take place.

Learners are made aware of and trained in the new system, which places the learner at the heart of the construction of knowledge in order to develop the skills needed to be autonomous, assiduous and available to follow and carry out weekly teaching and learning activities, continuous assessments, exams either in person or online, activities in the fablabs and incubator, and preparation of online certificates (MOOC or others) integrated into the training curriculum. The awareness-raising component for parents of learners has helped to reassure and strengthen confidence in the system through platforms for monitoring learners' activities, and to establish a permanent framework for exchanges with the UVCI administration that encourage commitment to support in the acquisition of work equipment (government operation: "one student, one computer") and also guarantee internet connectivity.

According to UNESCO*, "African education systems must invest in the training of teachers and technical staff to ensure the sustainability of digital devices"* (UNESCO, 2023; Azoulay, 2025). UVCI has distinguished itself by developing solid expertise in the training and capacity-building of teachers in digital pedagogy. This marks a major turning point in the implementation of the LMD reform, by fully integrating ICT into educational practices and promoting key principles such as *"learning differently, teaching differently and assessing differently"* in the digital age. In accordance with Decree n°2015-775 of December 9, 2015, UVCI has a Department of Academic and Pedagogical Affairs (DAPA) whose mission is to promote digital education and pedagogical innovations and ensure scientific and technological support in Côte d'Ivoire's Higher Education establishments. As such, it is responsible for: (1) Ensuring the relevance of teaching resources before they are put online on UVCI's dedicated platform; (2) Producing, managing, and enhancing UVCI's teaching resources; (3) Coordinating and guaranteeing access to the digital library and digital documentation centers required for UVCI's educational and scientific activities; (4) Managing, maintaining, and developing teaching resource databases; (5) Designing and deploying pedagogical systems integrating ICT; (6) Training teacher-researchers to integrate ICT into their teaching practices; (7) Maintaining scientific and technological support, drawing on resources such as scientific journals and bibliographic databases; (8) Developing cooperation with higher education establishments offering face-to-face courses; (9) Drawing up and update the UVCI master plan; and (10) Coordinating with the departments concerned the design of UVCI's three-year Public Investment Program and budget programming. With a forward-looking vision, UVCI is asserting itself as a model university of the future, reinventing the frameworks of academic governance and pedagogical practices (UVCI, 2018).

To make this vision a reality, UVCI has structured a high-performance technological ecosystem, based in part on educational content production studios and learning platforms such as Moodle and Open edX. These infrastructures enable the creation, dissemination and capitalization of innovative, contextualized teaching resources. Thanks to its own pedagogical and scientific practices, UVCI is a laboratory of experimentation, conducive to the emergence of innovative solutions based on a multidisciplinary and entrepreneurial approach. It combines several teaching methods, including ODL, MOOCs and hybrid training. This flexibility was decisive during the COVID-19 health crisis. UVCI played a

central role in the rapid transition of Ivorian public universities to distance learning. It supported this change by training teachers in digital teaching methods and providing ongoing technical support, while respecting the autonomy, specific features and skills of each establishment.

For learners, UVCI promotes pedagogy centered on mostly online, asynchronous devices. This approach offers great flexibility, enabling students to progress at their own pace, according to their personal, social and professional realities. With over 10,000 students enrolled and more than 100 teachers trained in ODL methods, UVCI is contributing to an increase in skills in digital pedagogical engineering. Its work with UNESCO Institutes has helped strengthening its quality assurance and pedagogical resource sharing mechanisms, contributing to the definition of regional standards for online teaching.

Artificial Intelligence

The integration of artificial intelligence (AI), particularly Generative AI, into educational devices raises complex ethical issues: protection of personal data, transparency of algorithms, the fight against discriminatory bias, respect for human rights to ensure responsible and ethical use of technologies, in line with international recommendations (UNESCO, 2022a; 2022b; 2023). In recent years, UVCI has engaged in a sustained dynamic around emerging technologies, in particular AI, Blockchain, and Big Data. It has developed training and applied research programs, while regularly organizing scientific events such as scientific days, symposia and webinars. UVCI has also invested in promoting Open Science, notably through Open Access Week, the creation of a virtual library and the wider dissemination of scientific results. These efforts have been consolidated through national and international partnerships, notably with the UNESCO Chair in Bioethics, CAMES and UNESCO-ICHEI.

These initiatives were part of the implementation of international recommendations from UNESCO, as well as strategic frameworks such as the African Union's Agenda 2063, the United Nation's Sustainable Development Goals (SDGs), and for Côte d'Ivoire the National Development Plan 2021-2025. In part as a result, following a call for applications for the creation of new UNESCO Chairs, UVCI was selected to host the first UNESCO Chair in Côte d'Ivoire, dedicated to Artificial Intelligence, Humanities and Open Science (IAHSO). This Chair is fully in line with the implementation of UNESCO's 2021 Recommendations, both on: (i) the ethics of AI, for the common good, respect for human rights, social justice and environmental sustainability (UNESCO, 2022a); (ii) and Open Science, as a driver of innovation, transparency and sustainable development (UNESCO, 2022b). Through the IAHSO Chair, UVCI is laying the foundations for an ethical, inclusive and collaborative knowledge ecosystem, integrating AI and Open Science in the service of humanities and sustainable societies (Table 1).

Table 1: UNESCO Recommendations and Actions to be implemented at UVCI and the IAHSO Chair

UNESCO recommendation	Actions to be implemented (UVCI & IAHSO Chair)
1. Governance & ethics	Creation of an AI ethics committee, adoption of charters for teaching and research, development of institutional policies, transparency of algorithms and data, sensibilization and training
2. Open science & dissemination	Strengthening the virtual library for higher education and research, support for institutional repositories at universities and research centers, mass participation open science OER open-source, international collaborations
3. AI skills development	Creation of certificates and degree courses in AI (bachelor's and master's degrees), bootcamps, AI engineering, international collaborations
4. Innovation & hybridization	Virtual labs, AI tutors, simulators, and micro-certifications
5. Research & entrepreneurship	Developing partnerships (AI, humanities, SO)
6. Inclusion and equity	Translation of content into local languages, local development

Conclusion

UVCI embodies more than just a digital university model: it is the reflection of an African ambition to structurally transform higher education in the age of digital technology and AI. Its path, marked by pedagogical innovations and a strong commitment to the values of ethics, inclusion and openness, shows that credible and effective alternatives to traditional models are possible, even in contexts with limited resources. In a continent where youth is both a promise and a challenge, UVCI contributes to widening access to knowledge, democratizing educational opportunities and training citizens capable of meeting the challenges of the 21st century. The institution has demonstrated that higher education, far from being static, can become a driving force for adaptation, experimentation and resilience in the face of technological, social and economic change. By integrating the dimensions of open science and AI at the heart of its action through the UNESCO IAHSO Chair, UVCI is charting a promising course for an inclusive, innovative African university, connected to local realities and anchored in international standards. This dynamic offers concrete prospects for rethinking training, research and university governance in the service of sustainable, just and human-centered development.

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Chapter 7

Challenges and Opportunities for Digitalization and the Use of Artificial Intelligence in Ethiopian Universities

Temechegn Engida and Quentin Wodon[10]

Introduction

Ethiopia and other African countries face constraints to digitalization and the adoption of artificial intelligence (AI) in their education systems, including in higher education (UNESCO, 2023). In Ethiopia, efforts by the government have included the development of a Digital Education Strategy and Implementation Plan for Ethiopia (Federal Ministry of Education, 2023) and a National AI Strategy under development by the Ministry of Innovation and Technology. Ethiopia's Digital Education Strategy 2023-2028 is a comprehensive framework aligned with Ethiopia's Education Sector Development Program and broader Digital Transformation Strategy. Areas of focus include infrastructure, digital literacy, e-learning tools, and teacher training. The strategy aims to ensure that all students and educators may access the benefits digital tools provide, including online material, interactive content, and distance learning.

The strategy's implementation plan embraces public-private partnerships and collaborative stakeholder development. Key areas include greater access to broadband connectivity for schools, greater access to digital devices for students and educators, greater supply and access to localized e-content, and greater teacher training to support digital pedagogy. Yet while Adamu (2024) suggests that these and other policies and strategies to promote digitalization including in higher education in Ethiopia exist, poor internet connection, lack of adequate ICT infrastructure, lack of skilled human resources, and staff resistance to change remain as constraints. This last constraint among some teachers is unfortunate as Feyisa et al. (2024) suggest that technology-enhanced teaching and learning can be important elements of quality in education, with many teachers welcoming the opportunities that digitalization provides. As to obstacles for digitalization in libraries, Gedamu et al. (2018) mention copyright issues and lack of funds to support digital libraries, as well as incompatibility of digital library platforms for local languages, lack of digital library plans, policies, and procedures, and not surprisingly low speed of Internet connections.

Two initiatives from the Ministry of Education for higher education are worth mentioning specifically. First, the One Card System is used by universities to automate their operations, including the café, dormitory, library, access control at gates, clearance, and more. These processes are automated using one digital ID, with some universities managing to automate about 70 percent of their related operations through the system. Second, the e-Learning for Strengthening Higher Education (e-SHE) is an online platform for universities to engage in online learning. It is a multi-stakeholder initiative implemented by the Ministry in partnership with Mastercard Foundation, Arizona State University, Shayashone PLC, and all Ethiopian public universities. These efforts are promising but also have limits[11].

This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), discusses some of the challenges faced by Ethiopian universities towards digitalization and the adoption of AI to improve the services they provide to their students and staff, including course instructors. Two types of data are used for the analysis: (1) quantitative results from an online survey implemented by UNESCO's International Institute for Capacity Building in Africa (IICBA) across the continent in the context of the review of the African Union's Continental Education Strategy for Africa or CESA 2016-2025 (African Union Commission, 2025a) and the preparation of a new CESA for 2026-2035 (African Union Commission, 2025b); and (2) qualitative insights from interviews with ICT Directors at nine Ethiopian universities[12]. The data – both quantitative and qualitative – confirm that despite efforts by universities and the Ministry of Education, challenges remain. In what follows, key results from the online survey are shared first, followed by insights from the interviews. A brief conclusion follows.

10 The authors are with UNESCO's International Institute for Capacity Building in Africa (IICBA). The opinions expressed in this article are those of the authors only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA. This article was written as part of a larger research project jointly with the International Centre for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI), with thanks to the staff and leadership at UNESCO-ICHEI for funding this work.

11 Wondwosen Tamrat (2025) notes that the Ethiopian Education and Research Network (EthERNet) connects only public universities to enhance resource sharing, research, and project collaboration. The same applies to e-SHE.

12 First generation universities are those established in Ethiopia before 2000, including Addis Ababa University, Haramaya University, Hawassa University, Jimma University, Bahir Dar University, and Mekelle University. These universities tend to be among the most prestigious in the country.

Online Survey Results

As noted in Chapter 3 (see also Wodon, 2025), a dozen online surveys were implemented by UNESCO IICBA for the review of CESA 16-25 and the preparation of CESA 26-35. This included a survey for university respondents on higher education, research, and innovation. One of the questions in the survey was as follows: *"In September 2022, the Transforming Education Summit called for various actions to improve education systems, including digitalization. There are also new opportunities from AI in higher education. On a scale of 1-5, how important are the following constraints to digitalization and the use of AI in higher education, research, and innovation in your institution or country?"* Respondents were asked to rate potential constraints on a five-point Likert scale: (i) Not a constraint; (ii) Somewhat of a constraint; (iii) Average constraint; (iv) Important constraint; and (v) Very important constraint.

The following constraints were listed in the questionnaire: (1) Lack of infrastructure (e.g., insufficient internet, insufficient equipment, etc.); (2) Conservative academic culture; (3) Lack of funding opportunities; (4) Lack of technical support; (5) Lack of leadership and vision; (6) Management model of the institution too centralized or not promoting innovation; (7) Lack of collaboration among peers; (8) Unsatisfactory remuneration or incentives; (9) Faculty relatively old and not up to date with new techniques; (10) General lack of support of professional development; and (11) Other (please specify).

To complement the data from the online survey, interviews were conducted with ICT Directors or Team Leaders of four first-generation universities, denoted by A, B, C, and D to ensure anonymity in the responses received. Sentiment analysis was used to analyze responses from the interviews.

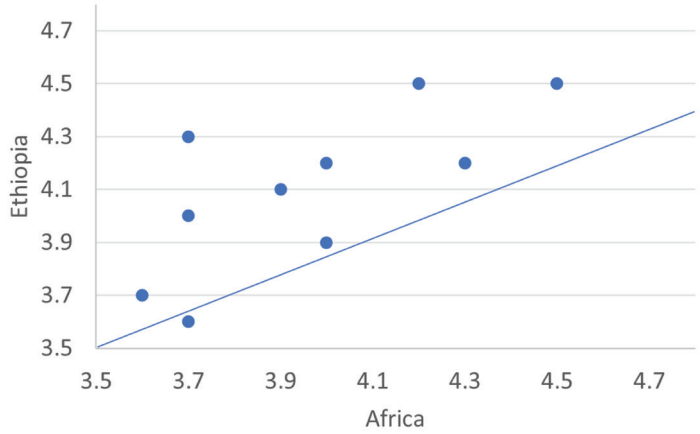
Table 1 provides summary results from responses through an average score taking a value from 1 (respondents rate a particular constraint as "not a constraint") to 5 (respondents rate the constraint as a "very important constraint"). Estimates are provided for all respondents from English-speaking countries, and the subset of respondents from Ethiopia. In Ethiopia, the two most important constraints cited are the lack of funding opportunities (4.5 rating) and unsatisfactory remuneration or incentives (also at 4.5), which also relates to funding. Other major constraints include an inadequate management model (4.3), a lack of infrastructure (4.2), a lack of professional development (4.2), a lack of leadership and vision (4.1), and a lack of collaboration among peers (4.0). Figure 1 visualizes the data in a scatter plot. The fact that most values are above the diagonal suggests more severe constraints in Ethiopia than on the continent.

Table 1: Importance of Various Constraints to Digitalization and the Use of AI in Higher Education, Research, and Innovation in Your Institution or Country

	English-speaking Africa	Ethiopia
Lack of infrastructure	4.3	4.2
Conservative academic culture	3.7	3.6
Lack of funding opportunities	4.5	4.5
Lack of technical support	4.0	3.9
Lack of leadership and vision	3.9	4.1
Inadequate management model	3.7	4.3
Lack of collaboration among peers	3.7	4.0
Unsatisfactory remuneration or incentives	4.2	4.5
Faculty relatively old/not up to date	3.6	3.7
Lack of professional development	4.0	4.2
Other (please specify)		

Source: Authors, from the CESA survey on higher education.

Figure 1: Scores on Constraints to Digitalization and AI adoption for English-speaking Africa and Ethiopia



Source: Authors of the CESA survey on higher education.

Insights from Interviews with ICT Directors

To better understand how digitalization was perceived in Ethiopian universities, interviews were conducted with ICT Directors/Team Leaders of nine universities, eight public and one private[13]. Fourteen questions were asked: (1) Universities are facing major challenges and opportunities with digitalization and AI. How would you rate the progress made by your university in these areas and why? (2) Does your university have clear priorities or strategies towards digital transformation and AI? If so, what are the key objectives and milestones? (3) How is digital transformation led and governed within your university? Are there dedicated teams or committees overseeing this process? (4) What initiatives are in place to train faculty and other staff on digital tools and AI technologies? How is the digital literacy of the academic community being enhanced? (5) How is technology used to enhance student engagement, both inside and outside the classroom? Are there any specific digital tools or platforms used for this purpose? (6) What is the current state of your university's IT infrastructure (network connectivity, hardware, and software)? What are the challenges you are facing? (7) How effective is your university in delivering online and blended learning? Are there specific challenges and opportunities? (8) Are digital resources such as e-books, databases, online journals available for students and faculty? What are challenges and opportunities to improve such availability? (9) Are faculty members encouraged to adopt innovative teaching methods that leverage technology and AI? How is this done? (10) How are digital tools used to assess student learning and performance? Are there any challenges in ensuring the integrity and fairness of online assessments? (11) Is technology used to make education more accessible, for example for students with disabilities? (12) Do you see any specific challenges and opportunities regarding the use of AI specifically? (13) Are there any other initiatives or innovations undertaken by your university that you would like to mention? (14) Finally, would you like to share a personal anecdote on how you personally have interacted with digitalization or AI? In what follows, responses to these questions are summarized with the respective universities/interviewees assigned labels from A to I for the purpose of anonymity.

Q1. Universities are facing major challenges and opportunities with digitalization and AI. How would you rate the progress made by your university in these areas and why?

Several universities (respondents A, D, E, G, and I) suggest significant advancements, while others, especially B, F, and H, made less progress. As noted by respondent C, while the university is relatively strong within the local context, it still lags global standards. A critical issue is insufficient ICT infrastructure, with responses highlighting a need for robust Learning Management Systems (LMS), multimedia studios, and adequate computer labs despite budget constraints and resource scarcity. Digital literacy among faculty, staff, and students is another constraint, with some respondents noting resistance to change and a lack of interest in adopting digital systems. Still, the COVID-19 pandemic accelerated a shift towards online and blended learning, with several universities actively developing online courses and utilizing LMS for assignment submissions. As for AI, it is used in specific applications, such as plagiarism detection, with a growing awareness of its potential alongside concerns regarding ethical implications and student misuse. Additionally, administrative digitalization is becoming increasingly prevalent, with processes like registration, HR, and finance benefiting from automation. This is exemplified by initiatives such as the "One Card System." Lastly, government initiatives, particularly the Federal Ministry of Education's e-SHE program, are playing a significant role in promoting digitization across the higher education sector.

13 Questionnaires were sent to ICT Directors of 13 universities of which nine responded.

Q2. Does your university have clear priorities or strategies towards digital transformation and AI? If so, what are the key objectives and milestones?

Many respondents (A, C, D, E, G, H, and I) indicate that their institutions either have clear strategies or are in the process of developing roadmaps for digital transformation. These strategies frequently encompass specific policies regarding e-learning, AI, and the utilization of digital resources, as noted by respondents A, F, and I. Moreover, the strategic plans are often integrated into broader university-wide strategies, as highlighted by C and I. Notably, respondent B points out that even in the absence of a formal strategy, universities are still pursuing actionable goals. The objectives of digital transformation primarily focus on enhancing teaching and learning through the development of online courses, integration of digital tools, and promotion of personalized learning (A, D, E, F, H). Additionally, improving administrative efficiency through the automation of core processes, digitalizing services, and implementing cashless transactions are common goals (B, G, I). Universities are also leveraging digital tools and online systems to support research and community services (B, C, E) while actively exploring AI-driven solutions—such as AI-assisted research tools and smart campus applications (A, D, E, G). Critical components of this transformation include upgrading ICT infrastructure, as noted by C, D, and H, and building capacity by training faculty and staff in digital skills and AI (D, G, H). There is a strong emphasis on data-informed decision-making, with many institutions utilizing data analytics and AI to enhance their processes (G, D). To monitor progress, universities are establishing milestones, such as launching online platforms and developing AI tools (A, D, E, G). Creation of e-learning units and committees underscores a commitment to governance and implementation (A, F). Finally, tangible advancements, like the establishment of data centers, indicate significant progress in the digital transformation efforts (C).

Q3. How is digital transformation led and governed within your university? Are there dedicated teams or committees overseeing this process?

A prominent theme in the context of digital transformation is the balance between centralized and distributed governance. ICT Directorates, or their equivalent IT department, play a pivotal role in spearheading digital initiatives (B, C, D, E, G, I). Nonetheless, there is also a notable presence of distributed governance, with contributions from e-learning units, task forces, and designated focal persons across different colleges and institutes (A, D, E, F, H, I). Some universities have taken a step further by establishing dedicated e-learning directorates or units (A, F, H). The ICT Directorate typically oversees the management of IT infrastructure, provides essential technical support, and coordinates digital efforts to align with university objectives (B, C, D). Yet achieving digital transformation necessitates collaboration and coordination among stakeholders, including ICT personnel, faculty members, administrators, and students (D, E, G, I). Focal persons and task forces serve to enhance communication and streamline coordination among various units, thereby facilitating a more cohesive approach to digital initiatives (D, E).

Q4. What initiatives are in place to train faculty and other staff on digital tools and AI technologies? How is the digital literacy of the academic community being enhanced?

Training initiatives are influenced by external programs, particularly those spearheaded by the Ministry of Education, such as the e-SHE projects mentioned earlier (A, C, E, F) and the government-initiated 5 million Ethiopian coders program (A, E, H). These programs serve as training resources, bolstered by partnerships with international organizations and foreign academic institutions (A, H). Emphasis is placed on e-learning tools and platforms, including Learning Management Systems (C, I), alongside basic digital skills training that encompasses data management and sharing (I). There is widespread acknowledgment of the necessity to enhance digital literacy among faculty and staff (C, I), prompting universities to adopt various strategies such as workshops, online courses, and faculty development programs to bridge these gaps (D, E, H). Furthermore, while foundational e-learning and digital skills training are predominant, there is an increasing focus on integrating AI training into faculty development initiatives (D, E).

Q5. How is technology used to enhance student engagement, both inside and outside the classroom? Are there any specific digital tools or platforms used for this purpose?

Learning Management Systems (LMS) can enhance student engagement by facilitating access to learning materials, enabling assignment submissions, providing feedback, and supporting virtual communication (E, I). Many universities opted for customized LMS platforms to better cater to their specific needs (F, I). Reliable Wi-Fi access is critical for student engagement, but infrastructure challenges, including conflict-related damage, hinder connectivity (A, D), leading to ongoing efforts to restore and expand Wi-Fi infrastructure (D). Online communication and collaboration have become prevalent, with platforms such as Telegram, WhatsApp, Zoom, and Teams complementing other online fora and collaboration tools (C, E, H, I). The implementation of online exams for internal assessments, exit exams, and international examinations reflects a growing trend towards digital assessment methods (D). Moreover, students are

actively participating in Student Success Suite courses available on the open edX platform, highlighting an emphasis on student support and development in the current educational landscape (F).

Q6. What is the current state of your university's IT infrastructure (network connectivity, hardware, and software)? What are the challenges you are facing?

Some institutions have made investments in robust infrastructure, such as Tier-3 data centers, high-speed broadband, and comprehensive Wi-Fi coverage (C, G). Other universities encounter challenges associated with outdated hardware, limited access to computer labs, and inconsistent network connectivity (C, H, I). Budgetary constraints complicate matters, posing significant obstacles to the development and maintenance of ICT infrastructure. This is exacerbated by rising costs of ICT equipment and difficulties associated with foreign currency transactions (B, C, D, E). Additionally, human resources and capacity issues persist, characterized by high staff turnover and a shortage of experienced IT professionals (D, E). This is compounded by low government salaries that hinder talent retention (C). Furthermore, gaps in skills related to digital course development among academic staff have been identified (A), highlighting a pressing need for staff capacity building, a recurring theme in the sector (D).

Q7. How effective is your university in delivering online and blended learning? Are there specific challenges and opportunities?

Some institutions have gained considerable experience, particularly during the COVID-19 pandemic (B, C, I), while others are in the nascent stages of planning or launching online programs (A, F, H). Many universities are leveraging the e-SHE platform provided by the Ministry of Education to facilitate this transition (C, D, G). However, several challenges impede effective implementation. One obstacle is faculty resistance, as some educators are reluctant to develop digital content or engage in online teaching (B, C, E). Infrastructure limitations, including shortages of computer labs, storage, backup solutions, and reliable internet connectivity, also pose major hurdles (A, D, E, I). Budget constraints again complicate the situation, restricting universities' ability to invest in infrastructure, equipment, and training (B, E). Power inconsistencies disrupt online learning activities, and skill gaps among staff hinder the development and delivery of effective online courses (A, B, E, G, I). To address these issues, motivating faculty through financial compensation or other incentives may help ensure a smoother transition to online education (C).

Q8. Are digital resources such as e-books, databases, online journals available for students and faculty? What are challenges and opportunities to improve such availability?

Most institutions offer access to a vast array of e-books, online journals, databases, and research repositories (B, C, D, E, G, H, I). Additionally, local repositories are utilized to archive student research work (C), while resources such as E-Library USA further enhance the digital landscape for some universities (I). However, several challenges impede the optimal utilization of these resources. Budget constraints again limit the ability to subscribe to newer publications and expand digital collections, with high subscription costs and currency shortages exacerbating the situation (C, E, H, I). Infrastructure challenges, including electricity interruptions, slow download speeds, and storage limitations further complicate access (C, E, H, I). Moreover, some universities have reported that the expected usage levels by students and faculty do not align with the available resources (A), and the lack of regular updates on digital platforms poses an additional obstacle (C). Nevertheless, opportunities exist to enhance the digital resource landscape. Participation in consortium subscriptions with other Ethiopian universities can broaden access to a more extensive range of resources (C, E), while the growing interest in research presents potential for increased utilization of digital tools (E). Improved broadband internet connectivity can enhance access to online resources (E), and partnerships with organizations, such as the US Embassy, can further expand availability (I). Lastly, ongoing digitization efforts of hardcopy books serve to enrich the pool of accessible resources (C), paving the way for a more robust academic environment.

Q9. Are faculty members encouraged to adopt innovative teaching methods that leverage technology and AI? How is this done?

Most universities demonstrate a commitment to encouraging faculty to adopt innovative teaching methods (A, D, E, F, H, I), as evidenced by various initiatives aimed at providing support through professional development programs, workshops, training sessions, and access to resources such as eLearning studios (D, E). Some institutions offer incentive packages, recognition, and small grants for project proposals to foster innovation (E, F, H, I). However, the adoption of innovative methods varies among faculty members. While some are actively utilizing technologies such as simulations, video assistance, and AI-based questions (B, C, H), others are engaging in individual efforts that have not yet been institutionalized (C). Certain responses indicate that the overall adoption rate does not meet expectations (H). On a positive note, there have been developments such as the creation of common plans with colleges for training and

digital course development (A), the establishment of e-learning guidelines coupled with incentive packages (F), and the provision of small grants for innovative project proposals (H).

Q10. How are digital tools used to assess student learning and performance? Are there any challenges in ensuring the integrity and fairness of online assessments?

The adoption of online assessment tools and platforms has become increasingly prevalent (A, B, C, D, E, F, G, H, I), encompassing a wide range of applications from applicant recruitment to student assessments, quizzes, and automated grading (A, B, E). Some institutions have even developed proprietary online exam management systems to cater to their needs (C, D). However, this transition is not without challenges. Key issues include ensuring the integrity and fairness of online assessments (C, D, E, F, I), tackling cheating and plagiarism (F, I)—particularly with the emergence of AI resources—and addressing inadequate ICT infrastructure which can impede effective implementation (B, H). A lack of digital literacy among educators (B), power interruptions (B, D), security concerns regarding unauthorized access (D, I), student account management complexities (G), and laboratory shortages (G, H) further complicate online assessments. To mitigate challenges, universities employ various strategies such as implementing proctoring technologies to monitor assessments and prevent cheating (D, F), utilizing plagiarism detection software like Turnitin to uphold academic integrity (D, E), and establishing ethical guidelines and regulations for online learning (E). Investments in ICT infrastructure and targeted training for both educators and students are needed for smooth functioning of online assessment systems (B, D, F, H).

Q11. Is technology used to make education more accessible, for example for students with disabilities?

Most universities express a commitment to making education accessible for students with disabilities (A, B, D, E, F, H). They use various assistive technologies for that purpose, such as the Job Access With Speech (JAWS) screen reader software for visually impaired students (D, E) and specialized software for those with visual and hearing impairments (C). Many institutions also provide assistive devices and alternative formats for learning materials (E), alongside web-based systems that are accessible with screen readers (B). Dedicated computer labs for students with disabilities further support this commitment (A, C). However, increased investment in specialized equipment and assistive technologies is necessary, along with the implementation of more comprehensive training programs for both students and faculty on the use of these technologies. It is also essential to address the needs of students with a wider range of disabilities beyond just visual and hearing impairments. Institutionalizing accessibility practices and policies is crucial, and there is a pressing need for increased efforts to assist the visually impaired (I).

Q12. Do you see any specific challenges and opportunities regarding the use of AI specifically?

The integration of AI in university education is reshaping learning, teaching, and administrative processes, with both significant challenges and opportunities. Ethical concerns arise regarding students' over-reliance on AI for assignments, which may impede the development of critical thinking and problem-solving skills (A, H), alongside issues of plagiarism and cheating (H). There are also concerns about potential biases in AI algorithms (H) and risks related to data privacy and security (G). Gaps in AI knowledge and skills among both faculty and students (D, G, H) call for more specialized expertise in AI and data science (G). Resource limitations, including high costs associated with AI implementation (G) and subscription fees (I) for AI resources, pose additional hurdles. Resistance to change from users accustomed to traditional educational processes (G) and the risk of students becoming overly dependent on AI tools (B), such as ChatGPT, may diminish independent thinking and creativity. The lack of coordinated initiatives for AI adoption within institutions exacerbates these challenges (C, D). Conversely, the opportunities presented by AI are substantial. AI can enhance decision-making through predictive insights that optimize resource allocation and improve operational efficiency (G). It allows for personalized education experiences, such as adaptive coursework and intelligent tutoring (E, G, H), while also streamlining campus operations through smart scheduling and predictive maintenance (G). AI may foster new research opportunities, promoting collaboration and technological innovation among students and faculty (G). It may simplify complex concepts (B) and automate various academic, research, and administrative tasks (E), ultimately leading to improved quality of service (B). Acknowledgment of AI's pivotal role in modern education (I) is essential as institutions navigate these transformative changes.

Q13. Are there any other initiatives or innovations undertaken by your university that you would like to mention?

Universities are increasingly pursuing external collaborations and partnerships to enhance their AI capabilities and drive digital transformation efforts (A, I, C). For example, collaboration with DEG Impulse has broadened the use of LMS, while partnerships with various Western universities have significantly elevated the technical capacity of ICT teams. Internally, some universities are establishing an independent e-learning directorate to coordinate online and blended learning

initiatives. Additionally, ICT consultancy services are being provided to other universities and government offices, which not only generates income but also helps retain skilled staff (C). The development of in-house software systems for administrative and academic functions is being prioritized to save costs and ensure sustainability (C, G). Incubation centers are being set up to engage students in innovative project ideas (C), and research labs for artificial intelligence applications are being established (E). The development of mobile applications for campus navigation, implementation of smart campus initiatives, and the introduction of cashless payment systems are also underway. Finally, efforts are being made to digitalize university documentation and utilize LAN connections for exam administration to mitigate connectivity issues (I).

Q14. Finally, would you like to share a personal anecdote on how you personally interacted with digitalization or AI?

Respondents reported a diverse array of personal uses of AI, employing it for tasks such as English editing, news preparation, clarifying complex concepts (A); preparing PowerPoint presentations, image editing, text generation, email communication (D), and analyzing student performance (H). There is widespread recognition of AI's potential to significantly enhance both productivity and creativity (A, D). In the realm of digitalization projects, respondents have led various initiatives, detailing both challenges and successes encountered (C, G, E). Challenges faced include a lack of awareness and commitment from top management, budget limitations, difficulties in persuading management to prioritize ICT investments, resistance from administrative sectors, and slowly shifting mindsets traditionally focused on construction projects. Conversely, successes include the development of the "One Card System" and the implementation of digital systems such as Electronic Medical Records (EMR), Student Information Management Systems (SIMS), Integrated Library Systems (ILS), and Learning Management Systems (LMS).

Conclusion

As in other African countries, universities in Ethiopia face challenges towards digitalization and the use of AI. Lack of funding is a key constraint, but other constraints matter as well. The objective of the first part of this chapter was to conduct a very preliminary diagnostic of such constraints, which in a stylized way may be useful to university administrators and policy makers when considering options for reforms. Thereafter, findings from interviews with ICT Directors of nine so-called first-generation universities were shared. These are some of the oldest universities and best-resourced universities in the country (Delel et al., 2020). The interviews suggest a strong commitment in those universities to advancing higher education through technology and effective leadership. Digitalization remains though in its infancy stage. While innovations and efforts from the Ministry of Education are commendable, a national strategy for digitalization and AI in higher education is probably needed to fully harness their potential. There is a great demand from the sampled universities for greater digitalization and incorporation of AI solutions.

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Chapter 8

Where Do Ghanaian Universities Stand on Digitalization and the Use of Artificial Intelligence?

Stephen E. Moore[14]

Introduction

Ghana is currently developing a National Artificial Intelligence (AI) strategy together with a National AI practitioners guide. The government has recently launched an ambitious One million coders program to train all manner of people in Ghana in AI development, designing and responsible use (MOCDTI, 2025). This agenda by the government feeds into a long-term national strategy towards digitization referred to as the Digital Transformation of the country. However, a very critical aspect of this digital transformation agenda is the tertiary education level. The tertiary education in Ghana comprises all formal post-secondary education, including universities, technical training institutes, colleges of education and vocational schools. The Ghana Tertiary Education Commission (GTEC) is the regulatory body overseeing tertiary institutions.

The rise in digital transformation in higher education, which is a result of the deliberate, system-wide attempt at teaching, research and administration through digital technologies is on the increase albeit several challenges still persist from the modernization to a strategic project. Smartphone penetration in Ghanaian universities has replaced notice boards with WhatsApp and Telegram groups, and students comparing notes on the latest generative-AI chatbots. Digital technology is no longer an activity relegated to the background; it increasingly shapes how courses are being taught, how research is done and even how the university hall and beds are allocated. The reasons for these trends can well be explained in three parts (Oxford Insights, 2023). First, Ghana is a young country with over half of its population under 25, thus the demand for flexible, technology-supported learning keeps rising. Second, improvement in connectivity means access to 4G signals in most district capitals, and data prices have experienced a sharp increase over the past year. Finally, the policy mood is changing. Ghana is one of the top performers of the African table in the *Government AI Readiness Index 2023*, and a draft *National Artificial Intelligence Strategy* promises new funding for skill development, research and start-ups**.**

In 2020 due to the COVID-19 Pandemic, many universities in Ghana discovered that their servers could not handle thousands of simultaneous logins and also university teaching staff needed training in e-learning. Since then, several projects backed by the World Bank and other partners have upgraded campus internet connectivity and trained staff on e-learning opportunities. Nevertheless, UNESCO's global rules on AI ethics also remind everyone that digitization also means protecting privacy and fighting bias.

In this chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), we present the current state of Ghanaian universities in the current global evolution of digitization. First, we will present the laws, investors and partnerships that shape what is possible. Then, we discuss the practical successes already happening in the classrooms, labs and administrations. We will consider five obstacles: weak infrastructure, lack of specialist staff, fragmented decision-making, patchy data protection, and limited money to keep talent at home. Finally, we also propose a roadmap for government, campuses, companies and donors to work together so that digital tools and AI serve every learner.

The rest of the article is organized as follows. In the next section, we discuss the policies developed to govern the AI ecosystem and some pertinent examples in Ghana. Thereafter, we discuss some of the opportunities and ongoing development that currently exist in Ghana. The next section 4 deals with persisting challenges in the digital space in universities with thereafter strategic recommendations. A brief conclusion follows.

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Policy and Ecosystem Context

Ghana's higher education digital landscape comprises a collection of mutually reinforcing policies, institutions and market actors. At the policy level, the National Artificial Intelligence Strategy 2023-2033 outlines eight priority themes including data governance, talent development, applied research, digital trade, infrastructure, responsible innovation, entrepreneurship support and international cooperation. Each of these themes has dedicated key-performance indicators such as shared research centers to AI courses in every faculty. There are complementary laws such as the Data Protection Act 2012 (Act 843) and the Cyber-Security Act 2020 that seek to enhance legal guard-rails on the uptake of AI in universities. The state's Digital Ghana Agenda plans for 95% 4G coverage and 80% fiber-to-campus connectivity by 2030 (World Bank, 2019). The existence of public policies thus creates a framework within which universities operate.

There is increasing public investment that seeks to match this policy clarity. For example, the World Bank's financed Ghana Digital Acceleration Project seeks to invest more than US $200 million into rural fiber spines, shared data centers and e-government services, with universities identified as anchor tenants for many of these links. Complementary domestic funds—from the Ghana Investment Fund for Electronic Communications and the revamped National Service Secretariat—support campus Wi-Fi upgrades and faculty up-skilling, ensuring that high-speed connections are met by people who know how to use them. Add in the Ministry of Communications' pledge to subsidize cloud services for accredited research groups, and a more level playing-field for smaller, regional universities begins to emerge.

Industry and civil society also supply innovation catalysts that spur the growth of AI. For instance, the recently reopened Google's AI Research Centre in Accra has signed multi-year sponsored-research agreements with the University of Ghana, Kwame Nkrumah University of Science and Technology (KNUST) and the African Institute of Mathematical Sciences (AIMS), to enable research and leadership sponsored programs developing young tech-talent in Africa. Swiss-based ETH Zurich's partnership with Ashesi University on a joint graduate program in Mechatronic Engineering exemplifies a growing pipeline of global North-South academic collaboration that shares curricula, laboratories and supervision duties. On the entrepreneurial front, the 2024 *Ghana Start-up & Innovation Ecosystem Report* recorded a 95% surge in annual venture investment, with total funding reaching US$121 million which signifies the surge in capital that is gradually aligning with digital opportunity. Incubators such as Ghana Tech Lab, MEST Africa and Soronko Academy, together with open-source initiatives like Khaya AI (African translation tool developed by Ghana NLP), broaden participation by offering short-cycle AI training and language-technology platforms for under-represented groups.

Opportunity Space

In Ghana, some universities are leveraging on the current enabling environment in four (4) intersecting domains. Pedagogy is shifting through the introduction of adaptive learning systems delivered over WhatsApp and SMS; preliminary pilots in senior-secondary science classes demonstrate measurable gains in concept mastery and learner engagement. For example, Kwame AI, enables senior high school students to type or speak West African Senior School Certificate Examination (WASSCE) science and mathematics questions and receive step by step answers in English, Twi or Ewe; early pilots report higher homework-completion rates and sharper exam revision habits (SuaCode AI, 2024). The ability of such innovations to run on low-bandwidth channels enable large student populations to benefit even at locations where laptop access is rare.

Research and knowledge production benefit from emerging AI laboratories working on disease diagnosis, climate-smart agriculture and satellite-based land-use analytics often in collaboration with multinational firms who contribute datasets and Graphic Processing Units (GPU) resources. Here, minoHealth AI Labs has produced deep-learning models that read blood-smear images and flag likely malaria cases which they seek to perform clinical validation with Komfo Anokye Teaching Hospital.

Institutional governance is improving as universities deploy predictive-analytics dashboards to forecast enrolment, optimize classroom allocation and monitor energy demand; a proof-of-concept at the University of Education, Winneba, where machine-learning dashboards now predict which courses will over-run classroom capacity and which students are likely to disengage, helping registrars balance timetables and send early-warning messages (Teye et al., 2025).

Finally, workforce development and entrepreneurship are expanding through bootcamps and incubation schemes that funnel skilled graduates into start-ups or corporate innovation teams, helping to mitigate graduate unemployment while seeding a domestic AI talent pool. For example, Ghana Tech Lab's national AI-Innovation Programme combines six (6) weeks of intensive coding with a two-month start-up incubator, funneling graduates with half of them women

into ventures that range from health chat-bots to logistics-routing engines. By lowering the cost of experimentation and surrounding novices with mentors and seed funding, such boot-camps keep bright minds in Ghana and nurture the next wave of home-grown AI companies.

Persistent Challenges

Ghana's tertiary education digitization agenda suffers from problems akin to most of sub-Saharan African universities, chief of which is infrastructure, which remains the most visible constraint. Internet bandwidth costs are still expensive, for instance, it is three to five times higher than in South Africa. Only three (3) public universities operate high-performance computing clusters capable of training modern deep-learning models. A survey of 326 University of Cape Coast students ranked unreliable campus Wi-Fi and server downtime as the top deterrents to sustained e-learning engagement (Addo, 2023).

Another important barrier is the capacity of the Ghanaian university faculties. It is reported that only 14% of computing lecturers in Ghanaian public universities possess a doctorate in an AI-related field, and heavy contact-hour obligations does not permit for research or curriculum innovation. Leadership interviews across three (3) campuses reveal that even staff with advanced qualifications struggle to access conference funding or seed grants, perpetuating a low-output equilibrium (Loglo, 2024).

In several instances, there is fragmentation of government good-intended plans that further complicates progress. Donor-funded pilot projects on digital-learning often bypass national coordination that leads to duplicated platforms, incompatible data standards and uneven quality assurance. In some instances, multiple institutions simultaneously negotiate software licenses, driving up costs and diluting bargaining power. Stakeholders interviewed in the World Bank's *Digital Economy Diagnostic* expressed concern that no single agency holds a comprehensive registry of higher-education digital initiatives, making systemic planning difficult (World Bank, 2019).

A fourth challenge is data protection and ethical oversight. The Data Protection Commission is responsible for ensuring data privacy and building trust in Ghana's digital landscape. Although the Data Protection Act, 2012 (Act 843) mandates registration of data-controlling institutions, compliance audits reveal patchy adherence and minimal enforcement. Institutional Review Boards (IRB) rarely include algorithm-governance expertise, raising the risk of unchecked bias in student-facing AI systems. UNESCO's global standard on AI ethics calls for bias audits, human-rights impact assessments and multilingual consent, practices that are only beginning to take root on Ghanaian campuses (UNESCO, 2021).

Finally, lack of sufficient funds or financial difficulties and difficulties in keeping skilled employees exert a drag on momentum. Domestic pension funds allocate less than one percent of assets to venture capital, well below the 25% regulatory ceiling, thus constraining the capital available for university spin-offs. Simultaneously, competitive global salaries lure top graduates abroad, draining the very talent pipeline universities strive to enlarge. The 2024 start-up report warns that persistent capital scarcity could stall the growth trajectory observed over the last two years (Innovation Spark, 2025).

Strategic Recommendations

A coordinated response is both feasible and urgent towards improving digitization and AI use in the universities in Ghana. Government through the Ministry of Communications, Digital Technology and Innovations (MOCTI) is financing the final passage of the national AI strategy among which includes a proposal to earmark some percentage of Gross Domestic Product (GDP) annually for campus fibre and shared computing centers; tax deductions on industry-university research and development (R&D) spending would further provide private capital. Universities can pool scarce resources through federated national high-performance-computing, embed ethics and entrepreneurship within all AI curricula, and institute mandatory bias audits for data-intensive projects. Industry partners can endow visiting professorship chairs, donate cloud credits and co-design capstone projects to ensure graduate skills align with market needs. International development partners such as African Development Bank, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the World Bank among them can blend concessional finance with technical assistance, while encouraging South-South faculty exchanges can accelerate capacity-building and improve gender representation in the AI.

Conclusion

Digitalization and AI are no longer peripheral enhancements for Ghanaian universities; they are strategic levers of national development. The opportunity landscape including personalized learning, frontier research, data-driven administration, and entrepreneurial spin-offs are vibrant, yet the lack of infrastructure and gaps in governance serves a threat to widen educational inequalities if left unaddressed. By coupling sustained investment with ethical stewardship and multi-stakeholder collaboration, Ghanaian universities can transition from incremental adopters to continental leaders, catalyzing innovation that resonates far beyond campus boundaries and setting a benchmark for responsible AI deployment across Africa.

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Chapter 9

Advancing Artificial Intelligence in Africa: Case Study of Pausti Master's Program in Artificial Intelligence

Losenge Turoop, Lawrence Nderu, and Rehema Ndeda[15]

Introduction

The Pan-African University Institute for Basic Sciences, Technology, and Innovation is one of the Institutes of the Pan African University (PAU), an African Union (AU) institution founded to promote innovative teaching, learning, and research in Africa. The African Union's Plan of Action for the Second Decade of Education for Africa recognized the need to revitalize higher education in Africa to drive achievement of the vision of the African Union Agenda 2063. PAU was conceptualized in 2008 and launched as a continental flagship initiative in 2011 by the African Union Commission. The PAU Statutes were adopted by the African Union Assembly in 2013. PAU undertakes training, research and innovation with a focus on priority issues. Continent-wide programs in science, technology, innovation, humanities and social sciences and governance are developed for capacity building of present and future stakeholders of the African Union.

PAU's model promotes the mobility of students and academic staff among African universities to improve teaching and collaborative research. This enhances internationalization as well as innovation in multi-disciplinary areas for problem-solving across Africa. The collaborative process also extends to the creation of mutually beneficial partnerships with public and private sectors within Africa and beyond, strengthening higher education and research in the continent. These activities have been important in improving the attractiveness of African higher education and research institutions, which in turn promotes the retention of talented young professionals on the continent. Competitive and growth-oriented research outputs have been pioneered and developed by graduates in areas having a direct bearing on the scientific, economic and social development of Africa.

PAU operates under the auspices of the African Union Commission's (AUC) Department of Education, Science, Technology, and Innovation (ESTI) as one university managed by a Rectorate supervised by a Council. Each PAU Institute is headed by a Director. PAU operates five institutes based on critical themes identified by the AUC as key to the development of Africa and attainment of the vision of the African Union. These thematic areas are: (1) Water and Energy Sciences including climate change (PAUWES, Algeria); (2) Basic Sciences, Technology and Innovation (PAUSTI, Kenya); (3) Life and Earth Sciences including health and agriculture (PAULESI, Nigeria); (4) Governance, Humanities and Social Sciences (PAUGHSS, Cameroon); and (5) Space Sciences (PAUSS, South Africa, this Institute still in planning stage).

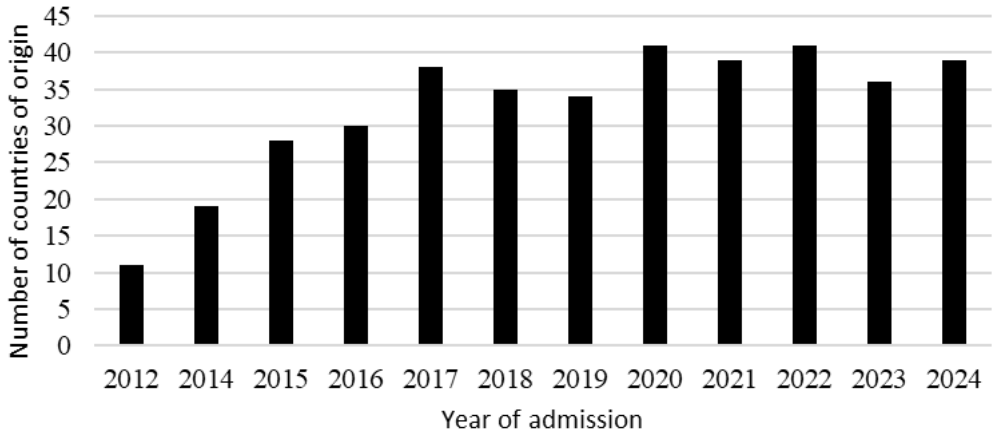
In alignment with the AU's Agenda 2063 and the Continental Education Strategy for Africa, PAUSTI is in the process of launching a flagship Master of Science in Artificial Intelligence, a first of its kind at PAU. This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), documents the rationale, development process, and strategic vision behind this initiative.

Programs at PAUSTI

PAUSTI is a postgraduate hub for research and innovation, featuring international faculty as well as students drawn from across Africa. The Institute is mandated to produce leaders and innovators in Basic Sciences and Technology. The Institute currently offers six master's programs and five doctoral programs. These programs are in the areas of Mathematics, Data Science, Molecular Biology and Biotechnology, Civil Engineering, Mechanical Engineering, Mechatronic Engineering and Electrical Engineering. The 1st Cohort at PAUSTI was taken in 2014, with international faculty. Together with other PAU Institutes, PAUSTI has more than 1,500 graduates from across Africa, with the benefits of internationalization of learning, capacity building, interdisciplinary research and innovation as well as creating a vibrant Pan-African academic network. PAUSTI itself has admitted students from more than 51 African countries, in line with the Agenda 2063 Aspiration on inclusivity. Figure 1 shows the number of countries represented in each intake of students at PAUSTI over time.

15 The authors are with the Pan-African University Institute for Basic Sciences, Technology and Innovation (PAUSTI) and Jomo Kenyatta University of Agriculture and Technology (JKUAT).

Figure 1: Number of African Countries Represented in PAUSTI Student Cohorts



Source: Authors.

International faculty and an industry-led curriculum design and implementation have been key strengths for the success of the program. The globalization of research outputs is done through publications and innovations. Publications by PAUSTI students in peer-reviewed journals have surpassed 360 in the past five years. Since the inception of PAUSTI, master's and PhD scholars have published 552 and 430 publications respectively. Several patents have also been filed. This indicates the capacity of the scholars to develop and deploy products with economic benefits for society and the continent.

Artificial Intelligence in Africa

The increasing demand and reliance on Information and Communication Technologies (ICT) in modern society is undeniable. Artificial Intelligence (AI) is widely recognized as a transformative force for economic development, service delivery, and societal change. The need for smart solutions to address complex challenges and harness new opportunities has placed AI at the forefront of technological innovation. Globally, AI is viewed as a general-purpose technology, with the capacity to revolutionize entire economic, social and development sectors. In Africa, AI holds the promise of leapfrogging historical barriers and unlocking inclusive and sustainable development.

Policy frameworks have been developed to reinforce the continental agenda on the adoption of technology as an enabler for development. The AU's Agenda 2063 articulates the vision of *"an integrated, prosperous and peaceful Africa, driven by its citizens."* Digital transformation, including the strategic use of AI, is seen as a key enabler of this vision. The Digital Transformation Strategy for Africa (2020–2030) endorsed by the AU Commission prioritizes the development of capacity in emerging technologies such as AI, big data, IoT, and blockchain to drive Africa's digital economy and future-ready workforce. The Continental AI Strategy for Africa developed in 2022 recognized the urgency to align technological progress with development goals. The strategy stresses the need for ethical, inclusive, and culturally contextualized AI development in support of priority sectors such as agriculture, health, climate resilience, education, and public governance among others. At the global level, the UNESCO Recommendation on the Ethics of Artificial Intelligence (2021) have been adopted by over 190 countries, including African states. It calls for AI systems that respect human dignity, environmental sustainability, and data sovereignty. These principles resonate deeply with Africa's aspirations for home-grown innovation, human-centered technology, and digital sovereignty.

While many professionals possess standard computing skills, Africa faces a significant capacity gap in the development and governance of AI. The Global AI Index shows limited African representation among countries leading in AI research and deployment. Challenges such as limited research infrastructure, uneven access to quality data, and a shortage of advanced AI expertise hinder the continent's ability to lead its digital future. This presents an opportunity to shape AI education. While different curricula have been developed globally, there is often lack of relevance to socio-economic realities of the African context. Integration of ethical and inclusive methodology that reflect African values, languages, and ethical frameworks would be useful.

Master's Program in Artificial Intelligence

It is against this backdrop that the Master of Science (MSc) in Artificial Intelligence at PAUSTI was conceptualized, as a Pan-African response to African needs. The AI program was conceived as a response to global digital transformation trends, AI integration in African public policy, as well as the need to position African graduates as creators of AI

technologies. Prior to the development of the curriculum, a needs assessment was conducted to understand industry demands and continental digitalization goals. The needs assessment also evaluated existing programs to prevent duplication of efforts. Design of the curriculum was carried out in collaboration with stakeholders, including faculty, alumni, and industry experts. The input of these stakeholders was incorporated into the curriculum which was then prepared for submission for accreditation.

In the needs assessment, stakeholders identify the need to align global development with local realities. While there was appreciation of different global applications, it was agreed that AI topics should be embedded within African development priorities such as climate change, public health, indigenous knowledge systems as well as local language technologies. A problem-based learning approach was proposed as a means of ensuring adequate upskilling in these application areas. There was general appreciation of the available policy frameworks. The necessity to align the curriculum with the existing Continental AI Strategy for Africa, Agenda 2063, and the Digital Transformation Strategy was reaffirmed. It was also suggested that graduates should be trained both to develop AI systems and to understand the ethical, regulatory, and socio-economic implications of their deployment. The curriculum was developed and validated based on these key ideas. The process for adoption of the designed curriculum within PAUSTI and Jomo Kenyatta University of Agriculture and Technology (JKUAT) was initiated by vetting at PAUSTI's Management Board and Senate as well as the JKUAT Senate. The curriculum was then submitted for quality assurance and onward submission to the Commission for University Education for accreditation.

The MSc degree in AI, which is set to be formally launched in the 2025/2026 academic year, is a two-year program that bridges the gap between the growing demand for locally relevant AI-powered solutions and the shortage of advanced AI professionals in Africa. It is designed to equip graduates with a thorough grounding in the core theories, principles, and practices underpinning AI. Students will gain hands-on experience applying structured, integrated methodologies in the design and engineering of both current and emerging AI systems, while also cultivating strong research skills to contribute meaningfully to AI advancement through independent inquiry and innovation. Learners will, through the program, develop the ability to clearly communicate complex AI concepts and design solutions across diverse audiences and use cases.

The program is delivered on a full-time basis through face-to-face instruction combined with labs, seminars, and project-based learning. Courses related to African realities are embedded within the program to offer contextual learning. These courses are History of Africa Entrepreneurship and Innovation and Human Rights and Gender. Core units that explore practically the different facets of Artificial Intelligence are included. These are: Machine Learning, Deep Learning, Generative AI, Large Language Models, Natural Language Processing and Computer Vision. A course on Ethics in AI is also taught. Finally, Research Methods offers insight into how to conduct research study. In the second year of study, the student will be expected to conduct a research study and develop a research thesis. Industry specific contexts will be provided within Kenya through engagement with industry stakeholders.

The inaugural cohort is set to be admitted in late 2025 and feature students from various African countries according to the PAU Student Selection Guidelines. The primary audience for the program includes individuals with undergraduate degrees in computer science, engineering, mathematics, or related fields seeking specialization in AI; mid-career professionals in IT related fields aiming to upskill for roles in AI-driven industries; early-career academics interested in AI research; entrepreneurs and innovators looking to integrate AI into scalable solutions for African markets.

In the initial stages of running the course, some limitations are expected, which reflect broader continental systemic issues. Supporting computing infrastructure is key in enabling research and innovation in AI. The Institute is currently engaging with current networks and research institutes with high-performance computing facilities such as the Kenya Education Network to support these training activities. Uneven access to quality datasets, particularly those that are locally relevant and ethically sourced, would potentially make it difficult to train and validate models suited to African contexts. This also presents an opportunity to create these contextual data sets for use in the future for education globally. A data repository is, therefore, envisaged at the Institute. In the initial stages of training, the shortage of advanced AI expertise is expected to limit areas of research mentorship. However, the Institute is already engaging research networks globally to offer requisite support which will ensure that the mandate is delivered accordingly and fulfilled without gaps.

Through this program, PAUSTI and JKUAT will aim to contribute directly to the realization of a digitally empowered Africa, where universities are not only recipients of global knowledge but active contributors to global AI ecosystems, rooted in the continent's values, challenges, and aspirations.

Conclusion

The launch of the MSc in Artificial Intelligence at PAUSTI represents a landmark in Africa's journey toward digital sovereignty and academic excellence. It highlights the role of collaboration between academia and industry in developing relevant curricula in higher education that will advance digital transformation. The approach demonstrates PAUSTI's vision to develop a new generation of AI experts who will drive the innovation and shape the global AI revolution.

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Chapter 10

Digitalization and Artificial Intelligence at the University of Calabar in Nigeria

Cecilia O. Ekwueme, Paul Adie, Mbe E. Nja, and Florence B. Obi

Introduction

The global shift toward digital education has accelerated dramatically in recent years, driven by advancements in technology, rising demand for flexible learning, and the disruptive impact of the COVID-19 pandemic. The University of Calabar's (UNICAL) digitalization journey reflects a strategic response to both global imperatives and national policy directions from the National Universities Commission (NUC), which has increasingly emphasized the need for technological integration into teaching, learning, and administration. The university's Open and Distance Learning Centre (ODLC) and its digitized Postgraduate School processes are two key pillars in this transformation. The ODLC aims to democratize access to university education by removing geographical and temporal barriers offering flexible, accessible and lifelong opportunities, while the digitization of the postgraduate school has streamlined core functions such as admissions, registration, result processing, and thesis submission.

This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), explores the initiatives, challenges and opportunities in digitalization and emerging AI integration at UNICAL. It documents the story of the ODLC's establishment, evaluates the digital turnaround of the postgraduate school, and surfaces both the institutional challenges and the opportunities that lie ahead. In doing so, the study draws on document analysis, stakeholder interviews, and user experiences to provide a balanced account of digital transformation in a federal Nigerian university.

Since its inception in 1975 as a federal university, UNICAL has embraced digital education. With a mission to *"produce high-quality graduates and professionals"* through excellence in teaching, research, and community service, UNICAL has grown to become one of the leading public universities in southern Nigeria. It boasts over 40,000 students across undergraduate and postgraduate levels and championed students' online digital profile through implementing intelligent digital identity system (IDID) and production of biometric-based intelligent identity cards. UNICAL is also home to one of Nigeria's fastest-growing Faculties of Education, known for training professionals in teaching, curriculum development, educational technology, and administration.

Before the wave of digital transformation, the university's administrative and academic operations were largely manual. Registration processes, result computation, fee payments, and academic communications were handled using paper-based systems, leading to inefficiencies, delays, and widespread student dissatisfaction. The teaching and learning environment, though effective in its time, was heavily reliant on face-to-face instruction. Lecture halls were often overcrowded, and access to quality instructional materials was inconsistent, particularly in faculties with high enrolment figures like Education, Management Sciences, and Social Sciences. The use of Information and Communication Technologies (ICTs) was minimal, with limited access to computers for both staff and students. Internet access was mostly confined to the university library where on-and-off information, e-journal and digital storage devices are all available for efficient search.

Efforts to integrate ICT into teaching and administration started slowly in the early 2010s, with the introduction of a basic student portal for registration and fee payments. However, this system had limited functionality and was often unstable. There was no dedicated e-learning platform, and attempts at computer-based testing (CBT) were restricted to a few programs. Despite the NUC's encouragement of ICT-driven learning, progress was sluggish due to funding constraints, lack of infrastructure, and competing institutional priorities. The tipping point came with the COVID-19 pandemic in 2020. Like many institutions globally, UNICAL was forced to suspend in-person activities for several months. This disruption laid bare the vulnerabilities of the analogue academic structure and prompted urgent efforts toward digital transformation. Thus, the pre-digital era at UNICAL—defined by manual operations, limited technology use, and systemic inefficiencies—laid the foundation for the digital leap that would follow.

Digitalization of Postgraduate School

The digital transformation of the School of Postgraduate Studies at the UNICAL represents one of the most significant strides in the university's journey toward administrative modernization. Faced with systemic inefficiencies, growing enrolment, and the need for faster academic processing, the postgraduate school's digitization was a deliberate institutional response to decades of paper-based limitations and stakeholder frustrations.

Before the digital reforms, the postgraduate school's operations—ranging from application processing to result compilation—were conducted manually. Prospective students had to purchase physical application forms, often from designated bank branches. Submission processes were slow, error-prone, and lacked transparency. Result computation, transcript issuance, thesis submission, and academic clearance were also dependent on physical documentation, which created bottlenecks and delays. This analogue system contributed to prolonged program durations and frequent student complaints.

Recognizing the inefficiency, the university's management, under the leadership of the Vice Chancellor and the Provost of Postgraduate Studies, prioritized the digitization of the entire postgraduate academic process. This effort was aligned with national and global trends pushing for automation and e-governance in higher education. The transformation began with the development of a centralized Postgraduate Portal, an online platform designed to handle end-to-end postgraduate processes. The implementation process involved collaboration between the university's ICT Directorate, external software developers, the postgraduate school, and internal Quality Assurance units.

Key modules of the system include online applications and admissions, digital registration and fee payment, results and transcript management, clearance and graduation processing. With these, there is improved efficiency, transparency and accountability, ease of access and Reduced Physical Contact. Yet despite progress, the digitization process has faced its share of challenges: (1) Resistance to change: Some staff members were initially reluctant to shift from paper files to digital records; (2) Training gaps: Not all administrative or academic staff possessed the digital literacy to navigate the new platform seamlessly; (3) Infrastructure limitations: Power outages, limited internet connectivity, and occasional portal downtimes affected smooth operation; and (4) Funding constraints: The cost of maintaining and upgrading the system continues to strain the university's limited financial resources.

Launch of Open and Distance Learning Center

The establishment of the Open and Distance Learning Centre (ODLC) at the UNICAL marks a pivotal step in the university's transition into the digital learning space and its broader mandate to democratize access to quality higher education. Several interlocking factors informed UNICAL's decision to launch its ODLC. First, there was a growing number of potential students unable to gain admission into the university's full-time programs due to space and capacity limitations. Secondly, the COVID-19 pandemic highlighted the vulnerability of education systems overly dependent on in-person learning. Third, the NUC's introduction of the Open and Distance Learning (ODL) Framework and its subsequent approval guidelines created both a regulatory pathway and an institutional incentive.

Internally, UNICAL's leadership — particularly the Vice Chancellor, Senate, and ICT Directorate — recognized that embracing distance education was not only about expanding access but also about positioning the university for relevance in a globalized, digital age. The university saw ODL as a channel for delivering quality education to working adults, geographically dispersed learners, and professionals who required flexible schedules.

The ODLC was not created overnight. Its launch followed a carefully phased approach involving policy development, infrastructural upgrades, capacity building, and external accreditation. The initial stage involved setting up an internal ODLC Planning Committee composed of ICT experts, educational technologists, academic representatives, and administrators. This committee drafted an institutional ODL policy in line with the NUC's minimum standards, addressing key components such as learner support, instructional design, content delivery, assessment protocols, and staff development.

With this framework in place, the university applied for NUC approval, which required site inspections, evidence of technical readiness, staffing profiles, and proof of governance structures. After a rigorous assessment, the University of Calabar was granted approval to commence ODL programs in selected disciplines, primarily within the Faculty of Management Sciences (Business Management). At the heart of the ODLC's functionality is its Learning Management System (LMS)—a cloud-based platform where lectures, assignments, assessments, and interaction are hosted. The LMS allows asynchronous (self-paced) and synchronous (real-time) learning and is compatible with mobile and desktop

devices. The ODLC also integrates video conferencing tools such as Zoom and Google Meet for live sessions, along with WhatsApp and Telegram groups for informal learner support and community-building.

The university's ICT Directorate played a crucial role in setting up the server infrastructure, managing cybersecurity protocols, and ensuring scalability. While the initial rollout featured open-source platforms like Moodle, the ODLC is currently exploring integration with more AI-augmented systems for content recommendation, automated grading, and learner analytics.

The ODLC is managed by a Director with important users as administrator, manager, teacher and student. Course materials are developed by subject experts in collaboration with educational technologists, ensuring that content is modular, multimedia-enriched, and aligned with NUC standards.

Each course has a designated Course Coordinator and e-Tutor, responsible for facilitating discussions, providing feedback, and guiding assessments. The administrative component includes a Monitoring and Evaluation Unit tasked with tracking course completion rates, student satisfaction, and platform usage. A Quality Assurance Desk officer regularly conducts internal audits and liaises with the NUC Directorate of ODL for compliance and improvement. Each process from purchase of admission form, online screening, paying acceptance fee and school fees have their specified easy steps.

Despite its promise, the ODLC launch faced multiple challenges, many of which were already alluded to earlier. This included: (1) Digital literacy gaps: Many students and staff had limited experience with online learning platforms and required extensive training; (2) Infrastructural constraints: Power outages, server downtime, and poor internet connectivity in parts of Nigeria posed barriers to smooth delivery; (3) Content conversion bottlenecks: Transforming traditional lecture notes into engaging multimedia content took time and required specialized skills; (4) Student skepticism: Some learners were unsure about the credibility and quality of ODL programs, especially in a culture that values face-to-face instruction; and (5) Sustainability concerns: Initial funding came from internal reallocations and TETFund grants, but sustaining the center over time requires a clear business model.

Feedback from learners indicates high satisfaction with the flexibility and accessibility of the platform, though issues with assignment turnaround times and platform responsiveness persist. Additionally, the ODLC has become a catalyst for pedagogical innovation across the university. Schools not yet part of the ODLC are now exploring blended learning models, flipped classrooms, and the integration of AI tools like plagiarism checkers and digital proctors into mainstream teaching.

Challenges and Constraints

While UNICAL's digitalization journey has been a commendable leap forward, it has also encountered several persistent challenges and systemic constraints. These issues, both technical and institutional, have shaped the pace, scope, and quality of the digital transformation process. One of the most pressing constraints facing the university is the inadequacy of ICT infrastructure. The campus is plagued by inconsistent electricity supply, outdated computing equipment, and limited access to high-speed internet. Although some progress has been made through ICT upgrades and server installation for the ODLC and postgraduate portal, these resources remain insufficient for a university of UNICAL's size and complexity. Students in rural or underserved regions, especially those enrolled in ODL programs, also face significant difficulties accessing reliable internet services and digital devices.

In addition, server downtimes and platform lags affect the user experience on the postgraduate portal and the LMS used by ODLC. These technical hiccups undermine trust in the system and slow down adoption rates, particularly among students unfamiliar with online learning environments. Another critical challenge is the limited digital literacy among staff and students. Many lecturers and administrative personnel had little to no experience with digital tools before the rollout of the ODLC and the postgraduate portal. While training workshops have been conducted, there remains a digital skill gap in the areas of content digitization, online assessment, data analytics, and student engagement.

Furthermore, students—particularly those coming from rural secondary schools—often enter the university with minimal exposure to computers or virtual learning environments. This mismatch between platform expectations and user readiness has led to low participation in some online courses and poor engagement with asynchronous materials. Resistance to change is another deep-seated institutional challenge. Some academic staff members continue to prefer traditional, paper-based systems due to comfort, fear of redundancy, or distrust in digital tools. In a few cases, faculty

members were reluctant to upload results or supervise research virtually, citing concerns over workload, platform instability, or lack of incentives. Similarly, students initially doubted the legitimacy and employability value of degrees earned via ODL programs, although this perception is gradually shifting. This cultural inertia is compounded by the lack of a comprehensive digital policy framework that could standardize digital teaching and learning expectations across faculties. While the ODLC and postgraduate school have developed internal protocols, there is no overarching institutional policy on e-learning or AI integration.

The financial sustainability of digital initiatives is a recurring issue. The digitization process has depended heavily on internal university funding, occasional support from TETFund, and grants from regulatory bodies. However, maintaining LMS licenses, upgrading hardware, training staff, and scaling digital services requires long-term investment, which the university budget does not always guarantee.

Revenue generation from ODL enrolment is not yet at the level needed to reinvest into infrastructure and innovation. As a result, there is a risk of stagnation if external funding sources or public-private partnerships are not secured. Finally, ensuring consistent quality in digital delivery has been another challenge. With online learning, issues like academic integrity, plagiarism control, and authentic student assessment have come to the fore. While some digital safeguards exist—such as anti-plagiarism software and identity checks for online submissions, gaps may remain.

Opportunities and AI Integration

While UNICAL has faced numerous constraints in its digital transformation journey, it also stands at a critical juncture where emerging technologies—particularly Artificial Intelligence (AI)—offer vast opportunities to enhance teaching, research, and administrative efficiency. One of the most promising areas of AI integration is in personalized learning. AI algorithms can track student interactions with course materials on the Learning Management System (LMS), identify learning gaps, and suggest targeted content or revision tasks. For instance, students who consistently perform poorly in quizzes or assignments could receive automated guidance or be flagged for tutor support. This adaptive learning model could be especially useful in large enrolment programs such as Education, Business, or Political Science. On the administrative front, AI has the potential to revolutionize how student services are delivered. A proposed AI chatbot system could respond to frequently asked questions related to admissions, registration, fee payments, thesis submission guidelines, and graduation clearance—thus reducing the burden on staff and minimizing long queues at service desks.

In the Postgraduate School, AI could be integrated to manage plagiarism detection, automated referencing checks, and submission compliance monitoring for theses and dissertations. These enhancements would not only improve academic integrity but also align the university with global scholarly standards. AI-powered data analytics platforms can enable the university to make evidence-based decisions. For example, by analyzing enrolment trends, course completion rates, and student satisfaction metrics, the university can refine its ODL offerings, allocate resources more effectively, and improve retention strategies. AI can also enhance research productivity. Tools like semantic search engines, automated literature reviews, and citation analysis software can support academic staff and postgraduate researchers in conducting high-quality investigations more efficiently.

As UNICAL's digital reputation grows, there are opportunities for collaborative AI research and funding partnerships with tech companies, government agencies, and international institutions. Such partnerships can offer access to infrastructure, capacity building, and pilot projects that embed AI into key university functions. Overall, the integration of AI at the University of Calabar is not just an opportunity—it is an imperative for relevance in a rapidly evolving educational landscape. With careful planning, investment, and training, AI can significantly enhance the quality, reach, and impact of UNICAL's digital education systems.

Conclusion

Considering the launch of ODLC and digital systems in the Postgraduate School, the university must prioritize stable electricity and high-speed internet across its campuses and digital centers. Investing in alternative energy sources such as solar backup for ICT facilities and establishing dedicated broadband partnerships with telecom providers can significantly improve service delivery and student access, especially for off-campus users. UNICAL should also formulate an institutional Digital Education and AI Integration Policy to standardize expectations, outline roles and responsibilities, and guide ethical use of AI. This policy should cover data privacy, academic integrity, online assessment protocols, and the governance of emerging technologies across all faculties.

Targeted capacity-building programs such as conducting regular training workshops on digital pedagogy, AI applications in education, and digital content development for lecturers, administrators, and students are crucial. Special emphasis should be placed on digital literacy for newly admitted students and support staff involved in distance learning operations.

To ensure long-term sustainability, the university should pursue multi-stakeholder partnerships with EdTech firms, AI research hubs, donor agencies, and regulatory bodies. These partnerships can provide funding, infrastructure support, and access to AI-powered learning tools. Exploring commercial ODL courses, executive programs, and digital certifications may also offer new revenue streams.

A centralized E-Learning Quality Assurance Unit should be established to monitor the performance of the ODLC, LMS functionality, student engagement, and tutor effectiveness. AI-powered analytics tools can aid in real-time monitoring of dropout risks, academic dishonesty, and learner satisfaction trends. Finally, there is a need for institutional campaigns to foster a culture that values digital learning through student orientation programs, digital ambassadors, etc.

UNICAL's journey toward digital transformation—highlighted by the digitization of its Postgraduate School and the launch of the Open and Distance Learning Centre (ODLC)—illustrates a progressive shift in Nigerian higher education toward greater accessibility, flexibility, and innovation. Despite facing infrastructural, cultural, and financial constraints, the university has made significant strides in laying the groundwork for a robust digital education system. The integration of digital platforms has enhanced administrative efficiency, expanded access to quality learning for non-traditional students, and sparked growing interest in the application of AI for personalized learning, academic support, and institutional management. These developments not only respond to immediate educational challenges but also align the university with global trends in smart and inclusive learning environments.

Looking forward, strategic investments in infrastructure, capacity-building, policy frameworks, and AI integration will be critical to deepening and sustaining these gains. With strong leadership, stakeholder engagement, and continuous innovation, the University of Calabar can serve as a national model for how public universities in Africa can harness digital tools and AI to transform learning and improve educational outcomes in the 21st century.

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While the chapter does not include formal citations, it relies on a series of internal documents available from the author. The reference to the broader study of which this chapter is part is Wodon, Q., Editor (2025). *Digitalization and the Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study.* Addis Ababa, Ethiopia, and Shenzhen, China: UNESCO IICBA and UNESCO-ICHEI.

Chapter 11

Teacher Education, Digital Skills, and Connectivity: A Case Study for Sierra Leone

Steve Nwokeocha, Aminata Sessay, Hungi Njora, and Quentin Wodon[16]

Introduction

Teacher education, both pre-service and in-service, is the foundation of teacher quality, with a key role for higher education institutions (HEIs) in preparing and keeping teachers up to date in their knowledge and practices. Sierra Leone's National Policy on Teacher Development and Performance asserts that teacher professional development (PD) shall consist of three key processes, namely: (1) An initial teacher education and training process in tertiary education institutions, leading to the acquisition of formal qualifications that are recognized by the Teacher Service Commission (TSC) as a basis for recruitment of prospective candidates into the teaching force; (2) Induction training processes provided during a probation period. First induction shall be immediately after graduation from a teacher education institution, and a second induction shall be within the initial 6-month period of employment; and (3) Processes of continuous and career-long professional development provided through formal and informal opportunities (Teacher Service Commission, 2020).

Teacher education matters for teaching standards and competencies – they are like two sides of the same coin. One cannot exist without the other, and their relationship is direct and mutual. This case study reports the situation of teacher education in Sierra Leone, considering first pre-service education, then continuous PD, and finally the Education Sector Plan 2022-2026, with a focus on the issues of the digital skills of teachers and their level of digital connectivity. The study is adapted and shortened from previous work (Nwokeocha et al., 2023), with a focus on the perspectives from teachers and school leaders.

At the onset, it is important to note that many teachers can be considered as untrained and unqualified. This may affect a third of teachers based on data from the National School Census (Ministry of Basic and Senior Secondary Education, & Ministry of Technical and Higher Education, 2022). TSC has identified some 4,500 teachers on Government payroll that may need to be let go, but it also recognizes the difficulty of employing additional qualified teachers as well as the need to implement a licensing framework for teachers and school leaders (Teacher Service Commission, 2021). The number of new teachers approved for employment falls short of what is needed. Both deficiencies in pre-service teacher education and shortages of qualified teachers are major challenges, with an important role to be played by HEIs in upskilling the teaching workforce. In this chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), the focus is first on pre-service education, next on in-service PD and finally on digital skills and teachers' ability to connect digitally. A brief conclusion follows.

Background on Pre-Service Education

Pre-service education is the first course of preparation for teachers. Factors affecting the quality of pre-service education are complex. For example, Chalmers (2008) lists five dimensions – assessment, engagement and learning community, diversity of teachers and students, and institutional climate, and systems that may affect the quality of the training received. He also pays attention to the quality of relationships at various levels such as an institution, its faculty, departments and programs, and teachers or individuals. Training in higher education involves inputs, processes, outputs, and outcomes.

In Sierra Leone, teachers with only a Teacher's Certificate outnumber other categories. The levels of qualifications recognized in the country are listed in Table 1. They range from the Teachers' Certificate to a master's or PhD. Entry requirements into pre-service education programs remain relatively low as shown in the Table. For instance, entry into the Teachers Certificate Program is provided for those who have "Attempted West African Senior School Certificate

16 This chapter is adapted from a report on the national framework of professional standards and competencies for teachers and school leaders in Sierra Leone which benefited from support from the municipality of Shanghai. The opinions expressed in the chapter are those of the authors only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA and the members of its Governing Board.

Examination (WASSCE)"; have two credits in WASSCE; or passed the entrance examination. Most teachers only have a Teacher's Certificate, which falls short of the minimum quality required to teach in primary education. In addition, there are numerous challenges facing teacher training institutions in terms of shortage of teaching staff, infrastructure, and teaching and learning resources.

Table 1: Recognized Teacher Qualifications in Sierra Leone and their Features

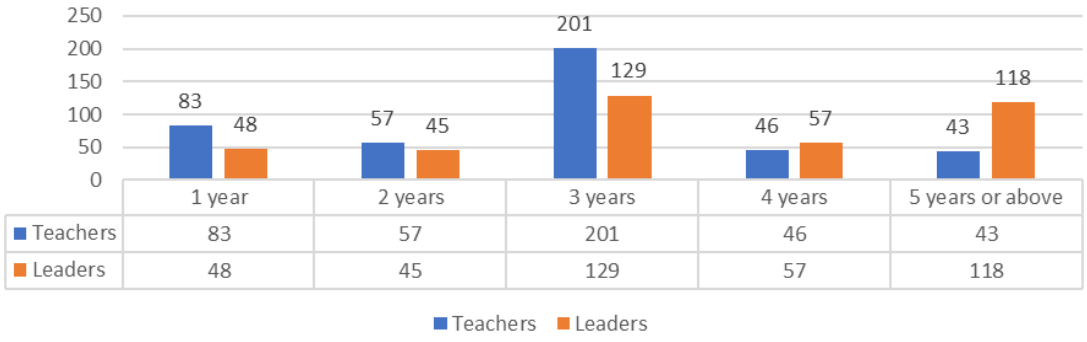
Teacher Qual.	Primary School		Secondary School		Teacher Education Institution Awarding the Qualification		
	Years	Qualif. Obtained	Years	Qualif. Obtained	Type of Institution	Entry Qualif.	Years
TC Primary	6	NPSE	6	WASSCE, NVQ	Teachers Training Colleges, Polytechnics, and Universities	Attempted WASSCE; 2 credits in WASSCE; or Pass in Entrance Examination	3
HTC Early Childhood HTC Primary HTC Secondary	6	NPSE	6	WASSCE, NVQ	Teachers Training Colleges, Polytechnics, Universities.	4 credits in WASSCE for HTC Secondary; 3 credits in WASSCE for HTC Primary; HTC Primary; TC + Experience	3
B.Ed/ Bachelors with PGDE/NDE	6	NPSE	6	WASSCE, NVQ	Universities and Polytechnics.	5credits in WASSCE	4 or 3 years for those with HTC or higher qualifications (direct entry)
M.Ed/ Masters with PGDE/ NDE	6	NPSE	6	WASSCE, NVQ	Universities		2
PhD in Education/ PhD with PGDE/ NDE	6	NPSE	6	WASSCE, NVQ	Universities		3 or 4

Source: Ministry of Technical and Higher Education (2021).

Note: TC: Teacher Certificate; HTC: Higher Teacher Certificate; NDE: National Diploma in Education; NPSE: National Primary School Certificate; NVQ: National Vocational Qualification; PGDE: Post Graduate Diploma in Education; Qualif.: Qualification; WASSCE: West African Senior Secondary School Certificate.

Based on an online survey of teachers and school leaders, Figure 1 shows that among respondents, 83 teachers and 48 school leaders spent just one year in their teacher training institution. Another 57 teachers and 45 school leaders spent two years, with the majority (201 teachers and 129 school leaders) spending three years. This information corroborates data suggesting that most teachers, being holders of Teachers' Certificate and Higher Teachers' Certificate, spent three years or less in teacher training institutions. Regarding the adequacy of the training received, as shown in Figure 2, most teachers and school leaders opined that their training was adequate. This self-rating, however, may indicate self-confidence rather than the reality of major deficiencies in teaching and learning observed in the country.

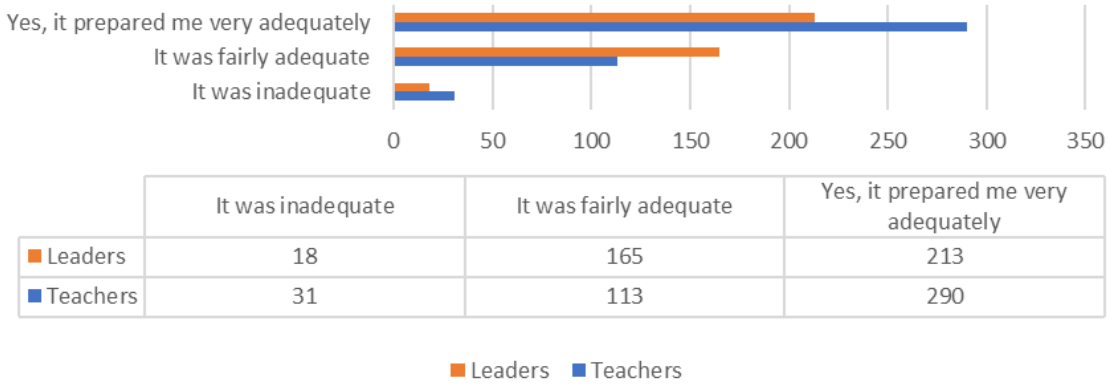
Figure 1: Duration of Pre-Service Education



	1 year	2 years	3 years	4 years	5 years or above
Teachers	83	57	201	46	43
Leaders	48	45	129	57	118

Source: Authors' estimation from online surveys.

Figure 2: Perception of the Adequacy of Pre-Service Education



	It was inadequate	It was fairly adequate	Yes, it prepared me very adequately
Leaders	18	165	213
Teachers	31	113	290

Source: Authors' estimation from online surveys.

Indeed, many teachers and school leaders also declare having faced challenges since becoming a teacher or school leader. Table 1 presents perceptions of these challenges. Among teachers who responded to the survey, only 113 (27 percent) indicated that they did not have any of the challenges listed for them. Some 108 teachers (26 percent) opined that the pre-service teacher education did not expose them enough to the practical skills they needed to plan and deliver lessons and other educational programs. For school leaders, while 82 (21 percent) stated they had none of the challenges listed, most also encountered challenges, with a substantial minority stating they had all the three challenges listed in the questionnaire. Half opined that pre-service teacher training did not expose them enough to professional knowledge (theories, principles, leadership styles, technology, financial management, change and innovation, etc.) needed for school leadership. Overall, the responses suggest a need for improving pre-service education.

Table 1: Key Challenges Faced Teachers and Leaders Since Becoming Teachers or Leaders

Teachers		School Leaders	
Options	**Yes**	**Option**	**Yes**
The pre-service teacher training did not expose me enough to the content of the subject that I teach.	51	The pre-service teacher training did not expose me enough to professional knowledge (theories, principles, leadership styles, technology, financial management, change and innovation, etc.) for school leadership.	194
The pre-service teacher training did not expose me enough to the practical skills that I need to plan and deliver my lessons and other educational programs.	108	The pre-service teacher training did not expose me enough to professional skills (planning and implementation of school programs, etc.) for school leadership.	50
The pre-service teacher training did not expose me enough to the ethics and expected conduct which I need to know about as a teacher.	65	The pre-service teacher training did not expose me enough to the ethics and conduct which I need to know about as a head teacher or principal.	18
I have all the three challenges listed above.	77	I have all three challenges above.	54
I do not have any of the three challenges listed above.	113	I do not have any of the three challenges listed above.	82
Total	414	Total	398

Source: Authors' estimation from online surveys.

In terms of the role of HEIs in pre-service training, there is unfortunately no national curriculum framework or benchmark for the Teachers' Certificate, Higher Teachers' Certificate (Primary) and Higher Teachers' Certificate (Secondary). For university-based degree programs, there is also no national curriculum framework. As a result, each college or university develops its own programs and gets approval from the Tertiary Education Commission, which makes it difficult to plan reforms across universities. Also critical is the fact that none of the pre-service education programs for teachers have received periodic external quality assurance visits in line with international best practices and prescriptions of the African Continental Teacher Qualification Framework (African Union Commission, 2019).

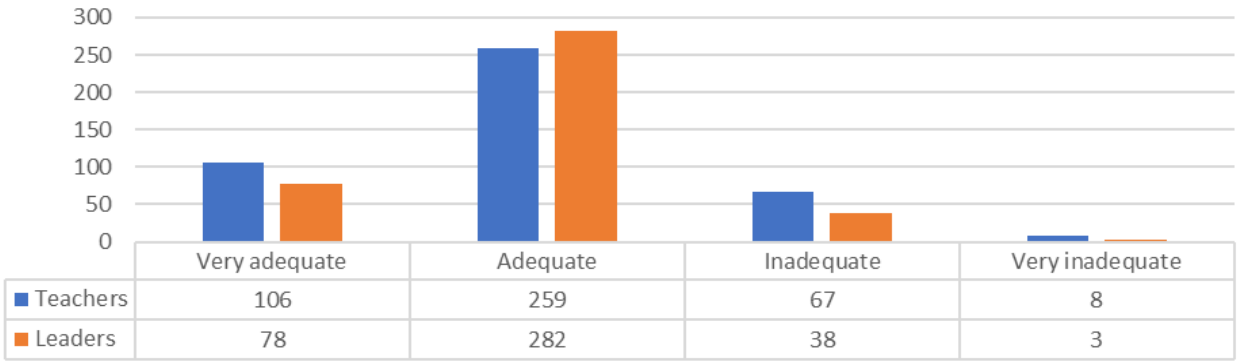
Background on Continuous Professional Development

Teacher continuous professional development (CPD) is the second major component of teacher education. It consists of various forms of training, education, and development spanning the career of teachers or school leaders. Sometimes these programs are broken down into further studies to earn higher or professional certificates, diplomas, and degrees; induction and mentoring; capacity building workshops, seminars, and conferences; and self-development that comes through individualized efforts and search for knowledge. No matter how excellent the quality of pre-service education is, CPD is indispensable for the teacher and school leader to keep abreast of required teaching standards and competencies and update their knowledge and practice.

TSC is the authority on matters of teacher professional development in Sierra Leone following a 2019 decision by the Ministry of Basic and Senior Secondary Education to transfer this responsibility and related assets to the Agency. TSC should not only have a CPD framework that binds all service providers together. but it should also serve as a hub or clearing house for funds, programs, administration, and use of CPD for the benefit of teachers and school leaders. Yet previous studies found that challenges persist and expert opinions from key informants suggest that these challenges remain unresolved. CPD often remains ad-hoc, reaching few teachers and school districts on a limited number of topics. There is no comprehensive, systematized approach that ensures that over time, all teachers should receive a specific set of CPD. Teachers and school leaders lack equal access to quality CPD, with most training funded by development partners, taking place as pilots in school districts chosen by them, and focusing on matters of their interest. It is also doubtful that CPD as it is currently implemented deals with fundamental requirements of the professional standards and competencies comprehensively. Importantly, the literature suggests that CPD should be mostly school based, including through Communities of Practice (CoPs) and learning clusters or circles. Ideally, CPD credits should be earned when teachers learn and improve their daily practices through action research, induction, mentoring, peer learning, and active participation in CoPs and learning clusters.

Teachers and school leaders responded to a question on the adequacy of CPD in the online surveys. As shown in Figure 3, many teachers and school leaders described (that is, perceived) it as adequate, but as for pre-service training, this does not imply that CPD is indeed adequate. In terms of the number of times teachers and school leaders attended a training event, workshop, or conference in the last three years, many teachers attended at least one training, which is encouraging but not a high number (the union and teachers themselves sponsored training more than government). Overall, while many teachers and leaders may feel that CPD is adequate, by international best practice it likely is not, including in terms of the amount of training received, and probably also in terms of the areas of focus of the training.

Figure 3: Adequacy of CPD Received Since Becoming a Teacher or Leader



	Very adequate	Adequate	Inadequate	Very inadequate
Teachers	106	259	67	8
Leaders	78	282	38	3

Source: Authors' estimation from online surveys.

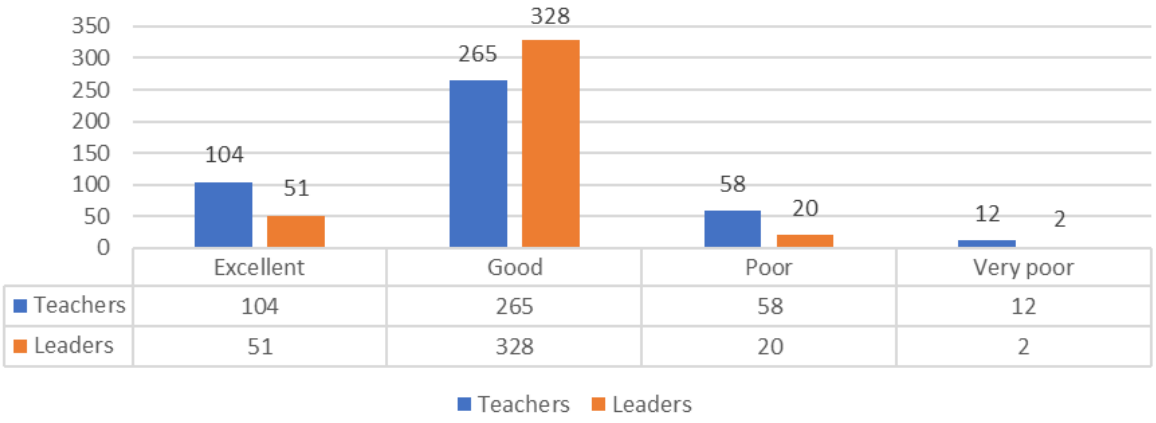
Finally, while CPD should count towards promotion, the perception of teachers and school leaders is that the assessment of their work by their supervisor matters even more. On the criteria for appointment and promotion, an overwhelming majority of teachers (282 or 65%) and leaders (308 or 77%) opined that the amount of CPD was a

criterion for promotion besides their years of experience. However, most teachers and slightly more than half of leaders stated that the supervisor's comments on their evaluation form counts more for promotion than the amount of CPD earned.

Digital Skills and Connectivity Issues

What is most relevant for this study are perceptions of teachers and school leaders regarding digital skills and the extent to which they are able to connect digitally, which matters for the type of support – including distance learning, that the Ministry, TSC, or HEIs may provide for upskilling over the teacher or school leader's career. As shown in Figure 4, most teachers and school leaders rate their capacity to access and use the internet as good or excellent, with only a small minority rating that capacity as poor or very poor. In addition, Table 2 shows that while most teachers and leaders have heard about professional development portfolios and own a smartphone, a majority do not own a laptop, nor do they have access to an official computer, laptop, or tablet. In practice, most teachers may therefore not be able to take full advantage of digital resources for teaching and learning even though they may have significant knowledge and skills in the use of computers and the internet.

Figure 4: Ability/Knowledge/Skill in the Use of Internet and Online Resources



Source: Authors' estimation from online surveys.

Table 2: Knowledge of CPD Portfolio, Ownership of Computer/Laptop/Handset, and Internet Access

	Teachers			School leaders		
	Yes	No	Total	Yes	No	Total
Have you ever heard the term "professional development portfolio"?	308	122	430	363	31	394
Do you have access to an official computer, laptop or tablet?	87	349	436	102	295	297
Do you have access to official internet connection/data?	88	352	440	85	313	398
Do you own a personal computer, laptop or tablet?	120	318	438	150	251	401
Do you own a smart phone?	348	89	437	356	44	400

Source: Authors' estimation from online surveys.

More detailed information from the online surveys is provided in Table 3 on connectivity (note that the data are provided by respondents who managed to go online to answer the survey, hence the situation for some teachers and school leaders is likely to be worse; in other words, statistics are biased upward). Access to mobile phone networks is typically good, but access to reliable internet connections is weaker, and many schools do not have electricity. This may be part of the explanation why teachers and school leaders find personal computers/laptops/tablets that they can use at home (where they may have access to the internet), more useful than official ones that may need to be used only in schools.

Table 3: Online Connectivity for Teachers and School Leaders

Questions & Responses	Teachers	Leaders
Quality of mobile phone network in your location		
Good	322	268
Poor	110	127
Non-existent	6	5
Total	438	400
Quality of internet connection in your location		
Good	293	250
Poor	127	149
Non-Existent	12	3
Total	432	402
Most beneficial to access online teaching content/preparing lessons		
Official computer/laptop/tablet	87	107
Personal computer/laptop/tablet.	286	277
Total	373	384
Electricity supply (public power supply or generator) in the school		
Yes	N/A	112
No	N/A	289
Total	N/A	**401**

Source: Authors' estimation from online surveys.

In terms of priorities for CPD, training in the use of educational technologies and teaching and learning online, and training for lesson plans and notes, lesson delivery, and learning assessment come first. Specifically, as shown in Table 4, for school leaders, training for lesson plans and notes, lesson delivery, and learning assessment comes first. For teachers, training in the use of educational technologies and teaching and learning online is mentioned more often. But both types of training would be appreciated by many teachers and school leaders. Capacity building to deepen knowledge in a teaching subject/area of specialization and capacity building in the instructional language (English) and in basic numeracy are mentioned less often as priority areas for training.

Table 4: Which Professional Development Program Do You Need the Most at the Moment?

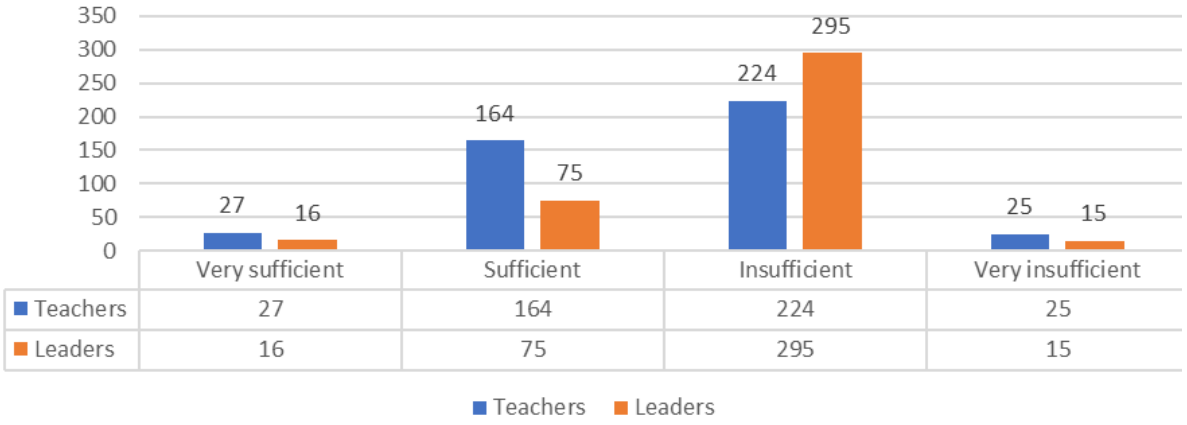
Teachers		Leaders	
Options	**Yes**	**Option**	**Yes**
Capacity building in the use of educational technologies, & online teaching and learning.	175	Capacity building in the use of educational technologies, & teaching and learning online	239
Capacity building in teaching methodology – lesson plan and notes, lesson delivery, & learning assessment.	223	Capacity building in teaching methodology – lesson plan and notes, lesson delivery, & learning assessment.	139
Capacity building to deepen knowledge in my teaching subject/area of specialisation.	25	Capacity building to deepen knowledge in my teaching subject/area of specialisation.	15
Capacity building in the instructional language (English) & basic numeracy.	14	Capacity building in the instructional language (English) & basic numeracy.	7
Total	**437**	**Total**	**400**

Source: Authors' estimation from online surveys.

Although this is less directly related to digital skills, perceptions regarding the availability of supplies and human resources are shown in Figure 5 where a clear majority of teachers and especially school leaders describe supplies and human resources as insufficient. An additional question asked to school leaders was about support they may need – responses suggest that training on leading professional knowledge, practice and conduct in the school is a priority. Figure 6 presents areas of CPD needed by leaders, based on the domains of the School Leadership Standards in the African Continental Framework of Standards and Competencies for the Teaching Profession (which do not make direct reference to digital skills). In descending order, the priorities are: (i) Leading professional knowledge, practice and conduct in the school; (ii) Generation of financial resources for the school; (iii) Promotion of school improvement,

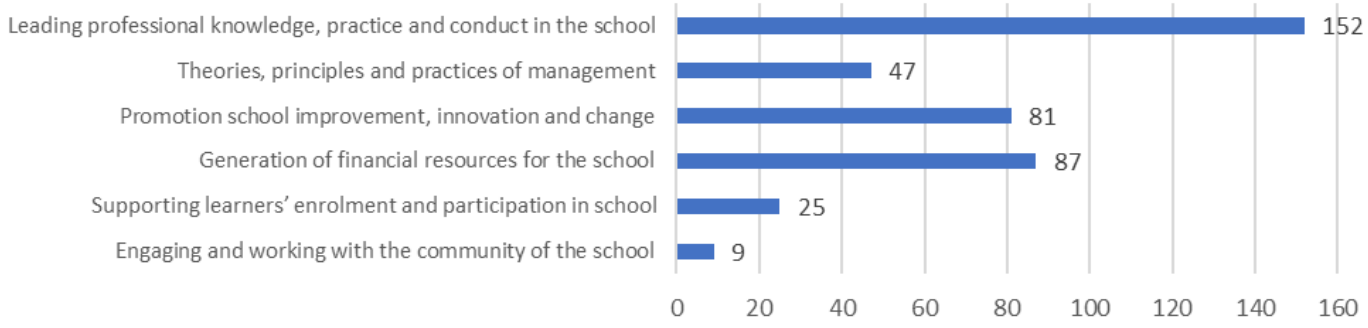
innovation and change; (iv) Theories, principles and practices of management; (v) Supporting learners' enrolment and participation in school; and finally (vii) Engaging and working with the community. The focus on strengthening professional knowledge and practical teaching methods likely reflects a similar expectation for digital skills, that training should prioritize practical, day-to-day application.

Figure 5: Ratings for the Supply of Teaching and Human Resources in the School



Source: Authors' estimation from online surveys.

Figure 6: Areas of CPD Needed by School Leaders



Source: Authors' estimation from online surveys.

Conclusion

In terms of broad findings from this case study on teacher education (with the more detailed analysis available in Nwokeocha et al., 2023), pre-service teacher education faces multiple challenges that undermine its quality. Teacher education is fundamental to improving teaching and learning, especially in a context where a large share of teachers do not have the minimum qualifications for teaching. Issues have been identified and require responses: (i) The regulatory and quality assurance frameworks for pre-service teacher education is weak; (ii) the TC is the dominant qualification in the school system, with at least 40 percent of the teachers considered as "untrained and unqualified"; (iii) even if teachers and school leaders opine that they had adequate pre-service education, retraining is likely needed in many areas.

Similar issues affect teachers' CPD. There is a lack of national framework for the regulation of CPD and an inability of TSC currently to exert its regulatory power over CPD programs. Government programs (and budgets) are insufficient to address CPD concerns, with only a minority of teachers and school leaders being trained each year. Another issue is the multiplicity of agents training teachers, often with their own preferences in terms of what training to emphasize, without effective coordination. CPD programs should have a positive impact on the professional capacities of teachers and school leaders yet may not count much towards promotion and advancement along the career path. CPD is being provided by the government, the teacher union and individuals themselves, but coordination may again be lacking.

As to digital competencies which is more the focus of essays in the exploratory edited by Wodon (2025), most teachers and school leaders feel that they have good or excellent knowledge and skills for using computers, the internet, and online resources but there are few official provisions for access to a computer, laptop, tablet, or the internet. In terms of priority needs for CPD, teachers and leaders emphasize capacity building in teaching methodologies and the use

of educational technologies, respectively, with school leaders also emphasizing training for leading professional knowledge, practice and conduct in their school. Many of these topics and issues have been discussed in the Sierra Leone Education Sector Plan 2022-2026. They also have implications for pre- and in-service offerings through diplomas, degrees, or certificates of HEIs.

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Chapter 12

Intentions, Barriers, and Tpack Readiness for Integrating AI in Science Education: Perspectives from South African Pre-Service Science Teachers

Lindelani Mnguni[17]

Introduction

Artificial Intelligence (AI) has rapidly emerged as a significant educational innovation with the potential to transform traditional teaching and learning practices, particularly within science education. AI tools offer several benefits, including personalized instruction, immersive learning environments, and adaptive assessment systems that enhance learner engagement and educational outcomes (Chou et al., 2022; Mnguni, 2023; Triplett, 2023). Despite these promising advances, integrating AI in educational contexts, especially within developing countries, continues to encounter multifaceted barriers and inconsistencies (Malinga, 2022; Mnguni, 2024). Understanding these challenges and their impact on educators' behavioral intentions to adopt AI is crucial for effectively leveraging AI's potential in education.

In South Africa, significant disparities in resource availability and technological infrastructure complicate the widespread adoption of AI technologies in schools (Malinga, 2022). While some urban institutions may have sufficient resources, rural and underfunded schools frequently struggle with inadequate internet access, limited technological resources, and insufficient teacher training (Chomunorwa and Mugobo, 2023). Consequently, despite the national push towards digital integration, gaps persist between policy objectives and practical classroom implementation (Shilenge and Ramaila, 2020). Therefore, addressing these structural and resource-related barriers is pivotal to achieving equitable AI integration across diverse educational environments.

Teacher preparedness and attitudes toward the adoption of technology play a critical role in the effective integration of AI into educational practices. The Theory of Planned Behaviour (TPB) posits that behavioral intentions are influenced by attitudes toward the behavior, subjective norms, and perceived behavioral control, with each construct shaped by specific underlying beliefs (Ajzen, 2014). Within educational contexts, teachers' beliefs regarding the usefulness of AI, their self-efficacy in managing technological tools, and perceptions of institutional and peer support significantly impact their readiness and intentions to integrate AI into teaching (Ayanwale et al., 2022; Howard et al., 2022; Mnguni, 2024). Research highlights that teachers who perceive AI as beneficial, manageable, and supported by their peers and institutions are more likely to integrate it effectively into their pedagogical practices (Ajzen, 2014; Laupichler et al., 2022).

Moreover, teachers' technological-pedagogical-content-knowledge (TPACK), which combines technological, pedagogical, and content expertise, significantly influences their capacity to implement AI effectively (Koehler et al., 2013; Mishra and Koehler, 2006). TPACK encapsulates teachers' abilities to appropriately integrate technology within their instructional methods and subject matter knowledge, thereby enhancing instructional quality and student engagement (Celik, 2023). Prior studies reveal that pre-service teachers often report limited competencies in technological knowledge and its integration with pedagogical and content knowledge, particularly in resource-constrained environments (Mnguni, 2024; Venketsamy and Hu, 2022).

Cultural and pedagogical resistance further complicates the adoption of AI in education. Traditional teaching methods, which emphasize direct human interactions, often conflict with perceptions of AI-driven methodologies, as some educators fear they might diminish their pedagogical roles or disrupt interpersonal classroom dynamics (Celik, 2023). Addressing such resistance requires targeted training programs that emphasize AI literacy, pedagogical adaptation, and supportive institutional cultures (Karaca et al., 2021).

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Given the multifaceted barriers to AI integration in South African education, this chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), aims to comprehensively examine pre-service science teachers' behavioral intentions toward AI adoption, their perceived barriers, and their technological, pedagogical, and content knowledge. Specifically, the objectives of this chapter are to: (1) Identify and analyze key barriers to integrating AI in science education, encompassing technological infrastructure, teacher attitudes, administrative support, financial constraints, and cultural resistance; (2) Investigate the determinants of pre-service teachers' behavioral intentions regarding the integration of AI, guided by constructs from the Theory of Planned Behavior (TPB) framework; and (3) Evaluate differences in self-reported TPACK among pre-service teachers based on their educational context (East Coast vs. distance learning).

Methodology

This chapter employs a mixed-methods research design to explore pre-service science teachers' behavioral intentions and perceived barriers regarding the integration of AI in science education. Initially, qualitative data were collected through online semi-structured interviews with participants from East Coast University and Central University, representing various socioeconomic contexts within South African schools ranked by quintile. Interviews focused on capturing participants' attitudes towards AI, their perceived advantages and disadvantages of AI integration, subjective norms, control beliefs, and perceived behavioral control. Thematic analysis was employed to identify prominent barrier themes, which included Technological Infrastructure, Teacher Preparedness and Attitudes, Administrative and Institutional Support, Financial Constraints, and Cultural and Pedagogical Resistance.

Following the qualitative phase, quantitative data were gathered using structured surveys informed by the Theory of Planned Behavior. This theoretical framework included constructs such as attitudes, behavioral beliefs, subjective norms, normative beliefs, perceived behavioral control, control beliefs, and behavioral intentions. Participants (n = 186) from East Coast University (n = 89) and Central University (n = 97) completed these surveys. Statistical analyses included descriptive statistics to evaluate overall trends and inferential analyses using the Mann-Whitney U test to assess significant differences between the two groups across TPB constructs.

The quantitative analysis further included examining participants' self-perceived TPACK. This was assessed using surveys with domains including Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Knowledge (TK), and their integrated forms, such as Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and comprehensive TPACK. Independent-Samples Kruskal-Wallis tests compared TPACK perceptions between East Coast and distance education contexts, exploring differences in Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK).

Data collection instruments underwent rigorous validation and reliability checks (Mnguni, 2024; Mnguni et al., 2024a, 2024b), employing Cronbach's alpha to ensure internal consistency and Spearman's correlation coefficients to confirm construct validity aligned with the Theory of Planned Behavior (TPB). This methodological combination of qualitative and quantitative approaches offered a robust understanding of the factors influencing pre-service teachers' intentions to adopt AI, encompassing contextual barriers, institutional resources, and pedagogical preparedness across different teaching and learning environments.

Results

The results highlight five key barriers to integrating AI in science education: Technological Infrastructure, Teacher Preparedness and Attitudes, Administrative and Institutional Support, Financial Constraints, and Cultural and Pedagogical Resistance. Each theme identifies specific obstacles such as inadequate resources, teacher apprehension about job displacement, lack of supportive institutional policies, high implementation costs, and resistance rooted in traditional educational practices. The provided evidence highlights concerns such as budget limitations, fears of redundancy among educators, slow administrative adoption, and cultural hesitancy toward replacing personal interactions with AI-driven methods.

Table 1: Perceived barriers to the integration of AI in science education

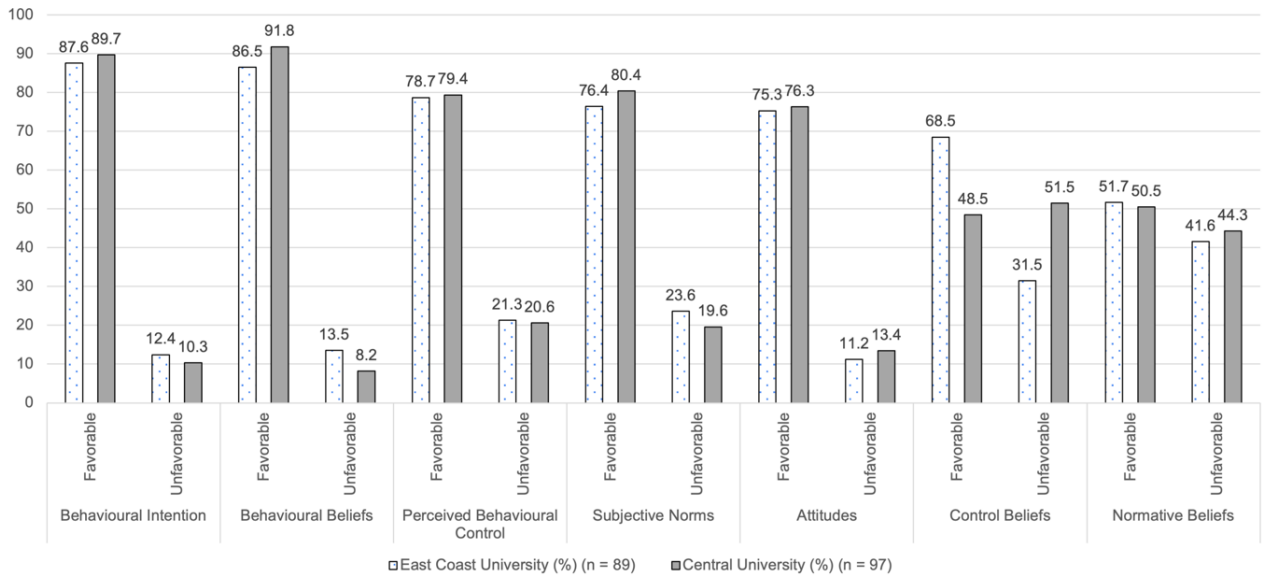
Theme	Definition	Evidence
Technological Infrastructure	Challenges related to inadequate technological resources, including hardware, software, and reliable internet access.	"In a well-resourced environment like my former Model C school, there'd be fewer obstacles, but at less affluent schools, infrastructure could be a big problem, especially reliable internet and devices" (Cindy)
Teacher Preparedness and Attitudes	Resistance or uncertainty among teachers due to a lack of training, confidence, or willingness to adopt AI technologies.	"The old [teachers] at the school? Some would be afraid of losing control or jobs to tech, fearing their roles becoming obsolete or diminished" (Sam) "My colleagues are a mixed bag; some are excited, others think AI might make them redundant or undermine their expertise" (Nomathemba)
Administrative and Institutional Support	Lack of clear policies, support, and commitment from school administration and governing bodies.	"Definitely the School Governing Body and the Department of Education would need convincing about investing and supporting the move to AI, as they're typically cautious and slow to embrace radical changes" (Luxolo)
Financial Constraints	Limitations due to high costs associated with implementing and maintaining AI tools and training.	"Funding would be a massive barrier, especially for public schools with limited budgets, highlighting the stark contrast between private and public institutions in resources" (Johan)
Cultural and Pedagogical Resistance	Resistance stems from cultural norms, traditional teaching practices, and prevailing educational beliefs.	"Look, I've always been more of a traditionalist. I think personal interaction is irreplaceable, and relying too heavily on AI could diminish that essential human touch" (Nomathemba) "Teachers who are comfortable with traditional methods may resist AI because they feel it undermines their expertise and devalues their established pedagogical methods" (Annalize)

Source: Author.

Behavioral Attributes Regarding the Integration of AI in Science Teaching

Results comparing pre-service student teachers' behavioral intentions toward AI integration at East Coast University and Central University showed high levels of favorable behavioral intention (East Coast = 87.6%, Central = 89.7%) and behavioral beliefs (East Coast = 86.5%, Central = 91.8%) in both groups (Figure 1). Similarly, highly favorable responses were observed in perceived behavioral control, subjective norms, and attitudes across both institutions, with minor variations. However, more notable differences emerged in control beliefs, where East Coast University reported a higher favorable response (68.5%) compared to Central University (48.5%). Normative beliefs and control beliefs were the lowest-rated constructs overall, suggesting potential concerns around external support and perceived agency in implementing AI in educational contexts.

Figure 1: Behavioral intentions for adopting AI in science education



Source: Mnguni et al., 2024a.

Further analysis showed no statistically significant differences between the two groups in attitudes (p = .806), behavioral beliefs (p = .179), subjective norms (p = .157), normative beliefs (p = .455), perceived behavioral control (p = .242), and behavioral intention (p = .794), as all p-values exceed the .05 threshold (Table 2). However, a statistically significant difference was found in control beliefs (p = .005), with a Z-value of -2.835. This suggests that student teachers from Central University reported significantly more favorable control beliefs regarding their perceived ability to implement AI in teaching. The consistency across most constructs indicates comparable perspectives between the two institutions, except control beliefs, which may reflect contextual or institutional differences in support, training, or access to AI-related resources.

Table 2: Mann-Whitney U Test Results

Comparing science student teachers from East Coast University (n = 89) and Central University (n = 97) regarding their attitudes, behavioral beliefs, behavioral intention, control beliefs, normative beliefs, perceived behavioral control, and subjective norms.

	Attitudes	Behavioural Beliefs	Subjective Norms	Normative Beliefs	Perceived Behavioural Control	Control Beliefs	Behavioral Intention
Mann-Whitney U	4249.0	3896.5	3874.0	4059.5	3917.5	3415.5	4231.5
Wilcoxon W	9002.0	8649.5	8627.0	8812.5	7922.5	7420.5	8236.5
Z	-.245	-1.343	-1.415	-.748	-1.169	-2.835	-.261
Asymp. Sig. (2-tailed)	.806	.179	.157	.455	.242	.005	.794

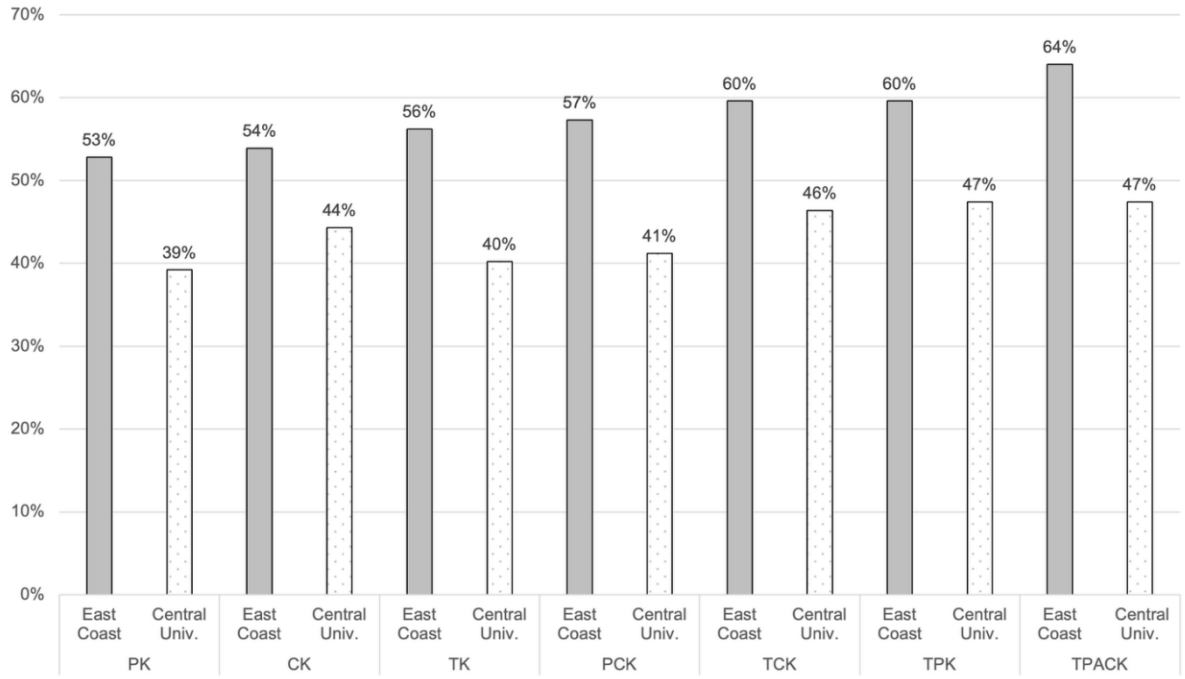
Note: Grouping Variable: University of current study.

Source: Mnguni et al., 2024a.

Pre-service Teachers' Self-Reported TPACK for Integrating AI in Science Teaching

Figure 2 shows that students enrolled at the East Coast University (East Coast University) reported higher self-perceived competence across all TPACK components when compared to their counterparts in the distance education context (Central University)(Table 4). Specifically, the East Coast cohort indicated stronger levels of Pedagogical Knowledge (PK = 53%), Content Knowledge (CK = 54%), and Technological Knowledge (TK = 56%) relative to the distance group (PK = 39%, CK = 44%, TK = 40%). This trend persisted across integrated domains, with notable differences observed in Pedagogical Content Knowledge (PCK, 57% vs. 41%), Technological Content Knowledge (TCK, 60% vs. 46%), and Technological Pedagogical Knowledge (TPK, 60% vs. 47%). The most substantial gap emerged in the composite TPACK domain, where East Coast students reported a 64% competence rate compared to 47% among distance students. These findings suggest that the East Coast mode of delivery may provide more robust opportunities for developing the interconnected knowledge bases essential for technology-integrated teaching.

Figure 2: Distribution of Self-Reported TPACK Components Among University Participants



Source: Mnguni et al., 2024b.

Results (Table 3) also revealed statistically significant differences were observed in three components: Technological Knowledge (TK) ($\chi^2 = 4.294$, $p = .038$), Pedagogical Content Knowledge (PCK) ($\chi^2 = 4.479$, $p = .034$), and Technological Content Knowledge (TCK) ($\chi^2 = 4.125$, $p = .042$). These findings suggest that students from East Coast University reported significantly higher levels of perceived competence in these areas. The remaining components—Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), and the integrated TPACK construct—did not show statistically significant differences ($p > .05$). However, the result for TPACK approached significance ($p = .058$). These results partially support the descriptive trends observed in the bar graph and highlight specific domains in which East Coast learning environments may offer a comparative advantage.

Table 3: Independent-Samples Kruskal-Wallis Test Results Comparing Self-Reported TPACK Components between the East Coast University and the Central University

	TK	PK	CK	PCK	TCK	TPK	TPACK
Total N	186	186	186	186	186	186	186
Test Statistic	4.294	2.521	1.001	4.479	4.125	2.507	3.592
Degree of Freedom	1	1	1	1	1	1	1
Asymptotic Sig. (2-sided test)	.038	.112	.317	.034	.042	.113	.058

Note: The test statistic is adjusted for ties. Multiple comparisons are not performed because there are less than three test fields.

Source : Mnguni et al., 2024b.

Discussion

This chapter has comprehensively explored the integration of AI in science education, identifying key barriers and determinants affecting pre-service teachers' intentions toward adopting AI tools. The qualitative and quantitative analyses revealed significant contextual and individual factors that influence AI adoption. Central among these were technological infrastructure deficiencies, inadequate teacher preparedness, limited administrative support, financial constraints, and cultural and pedagogical resistance. These findings align with prior research that highlights similar barriers in developing contexts (Malinga, 2022; Mnguni, 2024; Celik, 2023).

Consistent with the Theory of Planned Behavior, pre-service teachers generally exhibited positive attitudes and intentions toward AI integration, which were notably influenced by perceived behavioral control and normative beliefs. However, significant differences emerged regarding control beliefs between institutional contexts, particularly between students from East Coast and Central Universities. Central University students reported significantly higher perceived control beliefs, possibly reflecting differences in institutional support, access to resources, and contextual experiences with technology (Ajzen, 2014; Laupichler et al., 2022).

The quantitative findings on TPACK reinforced the role of comprehensive technological training in fostering effective AI adoption. Participants from East Coast learning environments reported higher self-perceived competence across TPACK domains, suggesting greater exposure to integrated technological instruction, which aligns with findings from other studies underscoring the benefits of East Coast-based teacher education (Koehler et al., 2013; Mishra and Koehler, 2006). Consequently, the disparity between East Coast and distance learning contexts highlights the need to enhance technological and pedagogical training in distance education programs. Interestingly, cultural and pedagogical resistance emerged as critical barriers, underpinning fears about diminished teacher roles and reduced interpersonal interactions, which align closely with previous findings on educator hesitance towards technology adoption (Karaca et al., 2021). Addressing these cultural and pedagogical concerns requires targeted professional development that emphasizes the complementary role of AI in enhancing teacher capabilities rather than replacing traditional instructional roles.

Conclusion

The implications of this chapter are significant for educational policymakers, teacher educators, and school administrators aiming to effectively integrate AI within science education. Firstly, targeted investment in technological infrastructure, particularly in resource-limited schools, is crucial. Government and private-sector collaboration could help bridge the digital divide by prioritizing equitable access to robust digital resources and reliable internet connectivity. Secondly, comprehensive teacher preparation programs must emphasize enhancing pre-service teachers' technological competencies and integrating these with pedagogical and content knowledge. Specifically, embedding robust TPACK frameworks within both East Coast and distance teacher education curricula is recommended, leveraging hands-on experiences with AI tools and technologies. Thirdly, fostering supportive institutional environments through clear policies and administrative backing is essential. Schools and educational departments should provide explicit policy guidelines, professional support networks, and continuous professional development programs to empower educators with the confidence and resources needed for successful AI implementation. Finally, addressing cultural resistance requires ongoing dialogue and targeted training programs that clarify the role of AI as a pedagogical tool rather than a replacement for human interaction. Professional development initiatives should include practical examples demonstrating the effective integration of AI in supporting, rather than supplanting, traditional pedagogical methods.

Based on the findings, it is clear that addressing infrastructure limitations, enhancing teacher preparedness through comprehensive TPACK training, fostering supportive institutional policies, and tackling cultural resistance collectively represent strategic approaches to optimizing the integration of AI within science education contexts. These recommendations can inform educational strategies and policies, ultimately contributing to the equitable, effective, and sustainable adoption of AI in educational settings.

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Chapter 13

Digitization at the University of Kara in Togo

Moutoure Yentougle[18]

Introduction

This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), looks at the experience of the University of Kara in Togo. Created by decree no. 1999-001/PR of January 21, 1999, the University of Kara is a public establishment of a scientific, cultural and professional nature within the meaning of law no. 2017-05 of June 19, 2017 on the orientation of higher education and research. This law positions higher education within the government's Education Sector Plan (PSE 2020-2030). It is on this basis that the government expects Togolese universities to guarantee citizens «*quality higher education in line with the job market*» by 2025, in accordance with the Ministry of Higher Education and Research's 2020-2025 roadmap, itself framed within the government's macroeconomic framework for that period and supported by the African Union's Agenda 2063 and the United Nations' Vision 2030 and its Sustainable Development Goals (SDGs).

However, due to demographic growth and an ever-increasing number of graduates, Togo's public universities are faced with a massification that contrasts with their infrastructure. An analysis of enrolments at the University of Kara reveals that the student population has increased by 15-fold since its creation in 2004. The evolution of student numbers at the University of Kara contrasts with the evolution of the infrastructure required to host the various teaching activities.

The university comprises of five schools and two Institutes: Faculté des lettres et sciences humaines (FLESH, for humanities and social sciences); Faculté de droit et des sciences politiques (FDSP, for law and political science); Faculté des sciences économiques et de gestion (FaSEG, for economics and management); Faculté des sciences et techniques (FaST, for sciences and engineering); Faculté des sciences de la santé (FSS, for health and medicine) ; Institut supérieur des métiers de l'agriculture (ISMA, for agricultural sciences); and Institut de formation en sciences pédagogiques et administration universitaire (ISPAU, for educational sciences). Enrollment data for the five schools and ISMA are provided in Table 1. The average number of students enrolled in semesters 1 and 2 in large schools such as FLESH, FDSP, FaSEG, and FaST is today well above 1,000. Yet the university has only one classroom with a capacity of 1,000 students, and two with 500-840 students. Limited infrastructure contributes to lengthening the academic years and learning difficulties experienced by learners, resulting by extension in a high failure rate.

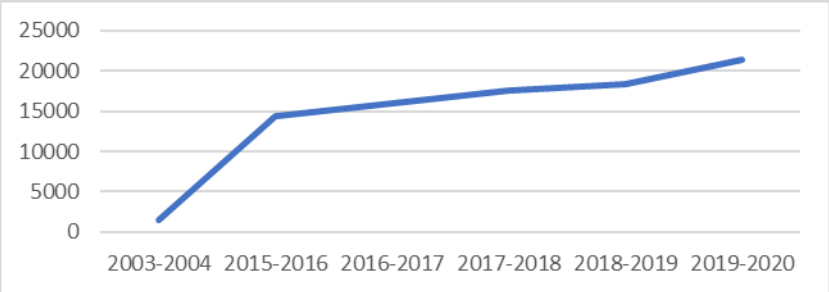
Table 1: Enrolment Trends by Faculty at the University of Kara

Schools	2003-2004	2019-2020
FLESH	770	13185
FaSEG	523	3983
FDSP	244	2098
ISMA	0	100
FSS	0	239
FaST	0	1852
Total	1537	21457

Source: Compiled by the author.

18 The author is Maître de Conférences de Sociologie urbaine with the University of Kara in Togo.

Figure 1: Student Enrollment at the University of Kara



Source: Compiled by the author.

In view of low intake capacity, there is a need to rethink teaching methods to meet the needs of an increasingly diverse population. The University of Kara, aided by the global health context marked by COVID-19, made a choice since May 2020 to provide online courses using Telegram. This new dynamic has engaged the university in a transformation of its teaching methods by combining its face-to-face courses with online courses. This dynamic marks a desire to dematerialize teaching materials, not only to enter the digital world imposed by today's realities, but also to reach a wider and more diversified audience. It is against this backdrop that the university is embarking on an experiment in digitally led hybrid courses using the Moodle platform, as part of a broader process of digitizing.

Early Developments

According to the 2017 law mentioned earlier, the University of Kara, like any other Togolese public university, has ten missions, including: (i) training in the most relevant ways, (ii) research and innovation for technological development, (iii) inter-university and international, scientific, technical, cultural and artistic cooperation, (iv) entrepreneurial and managerial culture and partnership, to name just these four missions. To lead the digitization process, the University of Kara has created a second deputy directorate within the central department in charge of pedagogical innovation and distance learning.

The understanding of a need for digital pedagogy emerged from a cross-reading between the Togolese government's National Development Plan (NDP) and the university's Ten-Year Strategic Plan 2014-2024. This led to the development of the NDP-university framework, with digital transformation as a flagship project. The challenge for the university is to contribute to the modernization of governance, pedagogy, research and community service delivery. For this purpose, two professional degrees were created: one in Multimedia and Internet Professions, and the second in Computer Science and Cybersecurity.

The COVID-19 pandemic hit Togo in early 2020 and accelerated the development of hybrid courses at the university, which chose the Learning Management System (LMS) for small groups of learners and Telegram for large groups. A survey of students found overwhelming support for this pedagogical approach, despite a lack of preparation and logistical resources coupled with internet connection difficulties. The university is now ready for digital teaching, despite structural and technical weaknesses. Under the impetus of its President, Professor Komla Sanda, the Agence Universitaire de la Francophonie (AUF) has trained around twenty of its teacher-researchers in digital teaching and the use of the Moodle digital platform, a more practical tool for putting courses online and distributing teaching materials. These teachers-researchers, having developed expertise in the field, in turn trained other university teachers-researchers and students. Forms filled in by participants at the end of the training and online course experience revealed that teachers were satisfied with the Moodle platform, practical for adopting new pedagogical approaches due to the diversity of resources it offers.

Challenges and Opportunities

Several challenges encountered by the university today should be mentioned. First, due to the lack of infrastructure, notably lecture theatres and classrooms, the academic year is extended by 9 to 12 months, with classes alternating between schools and departments to accommodate a large number of students in the lecture halls available. In recent years, there has been an overlap between the period during which courses are held (an average of four months per semester) and the period during which results are corrected and published. This has prevented students from taking full control of their academic careers.

The imbalance between the capacity of lecture halls and the number of students enrolled means that classes alternate between departments and faculties with high student numbers. Apart from leading to a longer academic year, this affects learners and teaching and administrative staff, including with overtime. Many and in some cases most students only attend classes outside the classroom and lecture theatres. Working conditions are affected, and so is the cost of infrastructure maintenance. It also limits the university's ability to reach a wider audience, particularly civil servants unable to follow courses under the conditions described, and it contributes to a high failure rate as well as a high drop-out rate. These conditions also lead to higher costs that could be avoided in the case of online courses. These higher costs include costs for exam invigilators, teams to process students' papers, marking bonuses, and printing exam flaps, not to mention the time it takes a teacher to mark students' papers by hand.

In this context, digital technology has become essential for an efficient and effective management system. The benefits of digital technology can be seen at the level of learners, parents, and the institution itself. It makes learning more flexible and helps serve a wider and more diversified public, while also supporting learners. Indeed, learners are more autonomous in their learning methods and more in control of their academic careers with online options. They are more sheltered from academic hardship, various forms of segregation, and so on. For parents, online courses enable them to better monitor and support their children's academic progress. As for the university, digitalization facilitates collaborations with other universities, while also making the university unique. Online courses therefore help to promote the university's international reputation. These are just some of the reasons why the university opted for hybrid teaching for all its courses and programs. Today, a total of 12,000 teaching units, divided into 185 courses, are offered in hybrid format, so that at least 20 percent of the teaching content is delivered online via the Moodle platform for all 22,000 students regularly enrolled. This process has required all lecturers (around 800), permanent or external, to produce digital content for the platform set up for this purpose.

Building on this experience, the university has also developed fully online courses for professionals seeking capacity building, reaching over 3,000 students. The programs that benefitted include the following: Master in agribusiness; Master in entrepreneurship and quality management; Master of accounting and taxation; Master in development planning; Master in ethics, evaluation and environmental responsibility; Certificate in university pedagogy; Certificate in volunteer management; Certificate in valorization of research results; MOOC in volunteering and citizenship; and MOOC in valorization of results. To support the digitization of teaching methods, the university has developed a digital library, which essentially consists of dematerializing the physical library. Students regularly enrolled in the physical library now have free access to digital documents available on the website. Digitalization has also made it possible to provide support for the visually impaired as documents in the digital library have been transcribed in audio format to facilitate audio consultation. Thanks to this system, it has also been possible to set up a plagiarism control system for documents produced by students, including for master's and doctoral dissertations. The digitization of documents has made it possible to control and compare documents produced at the university and elsewhere in the world before thesis defenses.

The digitization of pedagogy can only go hand in hand with the digitization of the student lifecycle, from registration to the issue of the diploma by the Department of Academic Affairs and Schooling. After testing various systems, the university enables students to register remotely, including submission of registration forms and payment of registration fees. The system also enables students' grades to be published and consulted remotely. Courses and exam timetables have been digitalized as well, as are exam reports.

Going digital does, however, requires paying attention to three challenges: reducing the digital divide, promoting leadership, and connecting decentralized services. Regarding the digital divide, social inequalities, if not managed in the context of online courses, can be reproduced. This requires reducing as much as possible inequalities in access to digital resources, particularly Internet connections and IT tools, so that all players in the chain are equipped to use digital systems and are connected to exchanges. Regarding leadership, a major challenge is to develop and motivate the leadership of teaching and other staff towards the digital transformation of the university, including by providing training on the importance and benefits of digital transformation. Finally, in terms of system-wide integration, the digital transformation of teaching must be accompanied by a digital transformation of administration, including laboratories and libraries, so that all sectors may be connected to a single regulated system.

References

While the chapter does not include formal citations, it relies on a series of internal documents available from the author. The reference to the broader study of which this chapter is part is Wodon, Q., Editor (2025). *Digitalization and the Use of Artificial Intelligence in Higher Education in Africa: An Exploratory Study.* Addis Ababa, Ethiopia, and Shenzhen, China: UNESCO IICBA and UNESCO-ICHEI.

Chapter 14

Digitalization and Artificial Intelligence at Bindura University of Science Education in Zimbabwe

Tarirayi Mukabeta[19]

Introduction

Bindura University of Science Education (BUSE), a leading institution in Zimbabwe's higher education sector, is advancing a bold and strategic agenda to digitalize its academic and administrative processes and integrate artificial intelligence (AI) in teaching and learning. This transformation is spearheaded by the Centre for Educational Technologies, Innovation and Design, in collaboration with various academic and technical units. With a focus on improving access, efficiency, and pedagogical effectiveness, BUSE's digitalization initiatives reflect global trends while addressing unique regional challenges.

Key milestones include the development of the MyBUSE Learning Management System (LMS), digitization of course content, and the adoption of AI-assisted tools in quality assurance and academic writing. The university has also invested in faculty training, developed institutional policies on digital learning, and supported student engagement through blended learning modalities.

Despite progress, BUSE continues to face structural challenges such as limited infrastructure, unequal student access to digital tools, and evolving capacity needs among staff. Nevertheless, its experience offers valuable lessons for peer institutions across Africa, particularly in leveraging digitalization for resilience, inclusivity, and academic excellence. This case study, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), outlines BUSE's journey in adopting digital technologies and AI, the challenges encountered, and the opportunities for future development in line with UNESCO's vision for digitally resilient higher education systems (UNESCO, 2021).

Background

Established in 1996, BUSE is a Zimbabwean public university with a strong mandate in science and teacher education. Situated in Mashonaland Central Province, BUSE serves over 8,000 students across undergraduate and postgraduate programs in Science, Education, Commerce, Social Sciences, and Agriculture. It is widely recognized for its contributions to STEM education and its commitment to improving the quality of teaching and learning through innovation.

Over the past decade, BUSE has made significant strides toward integrating digital technologies across its operations. The establishment of the Centre for Educational Technologies, Innovation and Design marked a critical turning point, institutionalizing the university's digital transformation agenda. The Centre oversees the development and deployment of eLearning systems, instructional design, content digitization, live lecture support, and faculty development programs.

BUSE's initial digital efforts were accelerated during the COVID-19 pandemic, which necessitated rapid adoption of online learning platforms. Since then, the university has formalized its approach by creating frameworks for digital course delivery, investing in cloud-based infrastructure, and aligning institutional policies with emerging AI technologies. These efforts position BUSE as a regional model for sustainable digital transformation in resource-constrained contexts (Dzvimbo and Dzvimbo, 2020).

The university's commitment to digital innovation is further reflected in partnerships with national ministries, regional institutions, and international organizations, contributing to policy dialogues and collaborative research on technology-enhanced learning in Africa (Maringe and Sing, 2021). Its experience offers valuable insights for UNESCO IICBA and similar bodies exploring the strategic integration of AI and digital tools in African higher education.

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Key Initiatives and Progress

BUSE has adopted a proactive and strategic approach to digital transformation, guided by its commitment to innovation in science education and inclusive access to higher learning. The university's digitalization strategy is embedded within its broader institutional development plan and is coordinated by the Centre for Educational Technologies, Innovation and Design. This strategy includes digital infrastructure enhancement, eLearning system development, AI integration, and capacity building for both staff and students.

In line with Zimbabwe's national digital economy framework and UNESCO's recommendations on the use of digital technologies in education, BUSE's strategy focuses on the adoption of learning technologies that improve teaching quality, support learner-centered approaches, and expand access to underserved communities (UNESCO, 2021; Ministry of ICT, 2020). The digital agenda is closely aligned with institutional quality assurance goals and is supported by a growing ecosystem of internal policies on online teaching, academic integrity, and responsible AI use.

A major milestone in BUSE's digital journey was the development and deployment of the MyBUSE Learning Management System (LMS). Built on open-source architecture (Moodle), MyBUSE serves as the central platform for course delivery, content hosting, assessments, and communication. The system supports asynchronous and synchronous learning modes and has become the foundation for hybrid and blended learning at the university. Since its launch, MyBUSE has seen continuous improvement, including integration with tools like Turnitin for plagiarism detection, Zoom for live lectures, and Google Workspace for productivity and collaboration. The LMS has facilitated more than 300 courses and serves thousands of students each semester.

BUSE has also begun piloting AI-supported educational tools in instructional design and academic writing. For example, Turnitin's AI writing detection is used in coursework and thesis submissions to promote academic integrity. Faculty and postgraduate students are increasingly using generative AI tools like Grammarly and ChatGPT for content editing, literature reviews, and research formulation. While these tools are still being used informally or in a semi-regulated manner, BUSE is in the process of developing an institutional framework to guide ethical and pedagogically sound AI use in teaching and learning, in line with emerging global standards (OECD, 2023; UNESCO, 2023).

Recognizing the centrality of capacity building, the university has trained over 120 faculty members in digital pedagogy, online course development, and the use of AI tools for teaching. These trainings, offered through short courses and departmental workshops, have improved digital literacy across faculties. The Centre for Educational Technologies runs continuous professional development sessions to equip academic staff with skills in instructional design, digital assessment, and educational media production. In addition, BUSE has invested in reliable internet bandwidth, cloud hosting services, and digital content studios for lecture recording and video editing. The university has also upgraded its network and data storage capabilities, enabling secure access to online learning services even in peak periods.

Students at BUSE have shown growing interest and confidence in engaging with digital and AI tools. The MyBUSE platform is actively used by students for course access, submission of assignments, and peer collaboration. With the rise of generative AI, students are beginning to use tools like ChatGPT for brainstorming ideas, drafting essays, and solving technical problems, although awareness of ethical usage varies. To address this, BUSE is developing student orientation modules on digital ethics, AI literacy, and responsible use of technology. There are also plans to incorporate AI education into select undergraduate and postgraduate curricula, particularly in computer science and education programs.

Challenges and Gaps

Despite strides in embracing digitalization and AI in higher education, the institution continues to face several significant challenges that constrain the full realization of its digital transformation agenda. These challenges reflect both local institutional limitations and broader structural issues prevalent in many African universities. One of the most persistent challenges is the uneven access to digital infrastructure among students and faculty. While the university has invested in bandwidth upgrades and learning platforms, many students come from remote or rural areas with limited internet connectivity and lack of access to digital devices. This digital divide has created disparities in participation, learning outcomes, and engagement with online and AI-supported learning tools (UNESCO, 2021; Dzvimbo and Dzvimbo, 2020). Additionally, the cost of data remains high for many students, making sustained engagement with online platforms difficult. Offline learning materials and low-bandwidth solutions are still necessary, though they often compromise the richness of interactive digital learning experiences.

Although BUSE has conducted extensive staff development programs, not all faculty members are fully equipped to design, deliver, or assess courses in digital or AI-supported environments. Some lecturers are still reluctant to adopt online teaching practices due to lack of confidence, time constraints, or skepticism about the effectiveness of technology-mediated instruction (Maringe and Sing, 2021). Moreover, integrating AI tools requires not just digital literacy but a nuanced understanding of AI ethics, data security, and educational effectiveness—areas in which many faculty members require additional support and training.

While BUSE has embraced the use of AI-related tools (e.g., Turnitin, Grammarly, and ChatGPT), it currently lacks a comprehensive institutional policy framework to govern their ethical, pedagogical, and legal use. The lack of formal guidelines has led to inconsistent practices across departments and limited understanding among students regarding acceptable AI use in learning and assessment. This gap raises concerns about academic integrity, fairness, and data privacy. UNESCO (2023) stresses the importance of developing institutional AI policies that address bias, accountability, and responsible use to guide both educators and learners in the AI era.

The sustainability of digital and AI initiatives at BUSE is often constrained by budgetary limitations. The university relies heavily on government subventions and donor support for digital projects, which may not be consistent or sufficient to support long-term infrastructure maintenance, platform upgrades, or innovation labs. Unlike some better-resourced institutions globally, BUSE does not have significant internal funding streams for research and development in AI or EdTech. This limits experimentation, local innovation, and the ability to scale up promising pilot initiatives (World Bank, 2021).

At the national level, Zimbabwe has made progress in developing digital economy policies, but specific higher education guidelines on AI and digitalization remain underdeveloped. Universities like BUSE must navigate regulatory ambiguity regarding issues such as digital credentialing, online assessment, and AI integration, often with minimal external guidance or support (Ministry of ICT, 2020).

Emerging Best Practices

BUSE has demonstrated notable leadership in the strategic adoption of digital and AI technologies in Zimbabwean higher education. While still a developing institution, BUSE has embraced several innovative practices that can serve as a model for peer institutions across the African continent. These emerging or best practices reflect the university's commitment to inclusive, quality education through the integration of technology.

A significant institutional best practice at BUSE is the creation of the Centre for Educational Technologies, Innovation and Design (CETID). This dedicated unit leads the university's digitalization and AI initiatives by coordinating the development of eLearning content, training staff, providing technical support, and conducting research in educational technologies. By housing innovation within a specialized unit, BUSE ensures continuity, quality assurance, and focused institutional capacity development (Dzvimbo and Dzvimbo, 2020). Such structural approaches are in line with international recommendations emphasizing the importance of institutional focal points to coordinate AI integration and digital transformation in higher education (UNESCO, 2023).

BUSE has progressively introduced AI tools into academic and administrative workflows, with a particular focus on academic integrity and writing support. Tools such as Turnitin's AI writing detection and Grammarly have been adopted across multiple departments. Faculty members are also exploring the use of generative AI (e.g., ChatGPT) to enhance curriculum design, provide formative feedback, and support postgraduate research. Although these tools are not yet governed by a formal institutional AI policy, BUSE's efforts to pilot and reflect on the responsible use of AI position it as a frontrunner in the region. The university is working toward developing AI usage guidelines that balance innovation with ethics and academic standards.

BUSE has institutionalized continuous professional development for both academic and support staff through workshops, short courses, and one-on-one mentoring in digital pedagogy and AI literacy. These programs cover content design for online delivery, use of AI tools, digital assessment strategies, and the use of media in teaching. For students, orientation sessions now include digital skills training and emerging discussions around the ethical use of AI tools. This approach aligns with global best practices in preparing learners for future work environments shaped by AI (OECD, 2023).

BUSE is actively aligning its practices with global and national frameworks, such as Zimbabwe's National Digital Economy Framework (2020–2030) and UNESCO's recommendations on AI in education. The institution has begun

drafting policy instruments related to online learning delivery standards, intellectual property for digital content, and responsible AI use. This alignment has enabled BUSE to participate in international networks and dialogues, ensuring that its practices are both locally responsive and globally informed (UNESCO, 2021).

BUSE's partnerships with government ministries and regional institutions reflect a best practice in leveraging multi-stakeholder collaboration for systemic change. The university has worked with the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development to roll out short courses on digital learning and has contributed to national strategies on higher education transformation. By fostering an ecosystem approach, BUSE is advancing digital education not just within its walls, but across the national education landscape, contributing to policy co-creation and capacity sharing.

Opportunities for Future Development

BUSE is strategically positioned to expand its digital and AI transformation efforts, particularly by leveraging national policy momentum, regional collaborations, and emerging technologies. Building on existing progress, the university has several promising avenues for future development in both institutional and academic domains.

One of the most critical opportunities lies in the formalization of a comprehensive institutional policy on artificial intelligence and digital learning. While AI tools are already in informal use by students and staff, the absence of a guiding framework has left room for inconsistency and misuse. Developing an AI policy will enable BUSE to set clear standards for responsible use, academic integrity, data protection, and pedagogical effectiveness. This effort could be informed by UNESCO's (2023) AI and Education policy guidelines and adapted to the local context. A robust framework would also facilitate compliance with international data ethics protocols, enhancing the institution's credibility and partnerships globally.

There is significant potential to embed AI education across the curriculum, especially in fields like computer science, education, health sciences, and business. By integrating courses on machine learning, data literacy, and AI ethics, BUSE can equip graduates with 21st-century competencies aligned with industry demands (OECD, 2023). In addition to technical disciplines, AI integration in the pedagogical training of future educators could improve the quality of instruction across Zimbabwe's school system, making BUSE a leader in preparing AI-literate teachers and educational leaders.

BUSE can amplify its innovation agenda by building strategic partnerships with local industry, government agencies, and international organizations. For example, collaboration with the Zimbabwe National Statistics Agency or Ministry of ICT can enhance AI-driven research projects and infrastructure development. Regionally, partnerships with SADC universities and institutions such as the UNESCO-ICHEI or UNESCO-IICBA can provide platforms for joint research, resource sharing, and staff exchanges. These collaborations can help BUSE access funding, expertise, and technology needed to scale its innovations (UNESCO-ICHEI, 2023).

Another promising opportunity is the use of learning analytics and AI-driven dashboards to monitor student performance, personalize learning paths, and identify at-risk students early. These tools can help improve student retention and academic success by enabling data-informed teaching interventions (Siemens and Long, 2011). As digital infrastructure improves, BUSE can implement adaptive learning technologies and intelligent tutoring systems to support differentiated learning—especially for large undergraduate classes.

Establishing a Digital Education Innovation Hub or AI Lab within CETID can support research and development of localized educational technology solutions. This would provide a space for interdisciplinary collaboration among students, faculty, and external partners to experiment with AI models, build apps, and design digital content tailored to Zimbabwe's context. This initiative aligns with African Union and UNESCO strategies on leveraging innovation for educational transformation, and it would help BUSE position itself as a regional leader in AI for education in Southern Africa (AU, 2022; UNESCO, 2021).

Conclusion

BUSE has made notable progress in its digital transformation journey, positioning itself as a forward-looking institution within Zimbabwe and the Southern African region. Through the establishment of the CETID, adoption of digital learning platforms, integration of AI tools, and sustained capacity-building efforts, the university has begun embedding innovation into its core teaching and learning processes. However, several systemic and structural challenges remain, including inadequate infrastructure, gaps in digital literacy among staff and students, the absence of comprehensive AI governance frameworks, and limited financial resources. These barriers must be addressed strategically to fully harness the potential of digitalization and AI in transforming education delivery, accessibility, and quality.

Drawing from both BUSE's experience and global best practices, the following recommendations can be made: (1) Develop and implement a comprehensive digital and AI policy: BUSE should finalize and institutionalize a university-wide AI and digital education policy, aligning it with national frameworks such as Zimbabwe's National Digital Economy Framework and international guidance from organizations like UNESCO. This policy should include provisions for ethical AI use, data privacy, academic integrity, and AI-driven assessment; (2) Enhance faculty and student digital competency: The university must continue to scale up its digital literacy training, targeting not only technical skills but also critical digital pedagogy and AI ethics awareness. Introducing AI fluency programs into orientation for students and professional development for faculty will support more responsible and effective technology use (Luckin, 2018); (3) Prioritize infrastructure investment and connectivity: Improving bandwidth, expanding campus Wi-Fi, and subsidizing device access for students—particularly those from rural areas—should be a priority. Partnerships with telecommunications providers or engagement in public-private partnerships can be explored to reduce digital inequality (World Bank, 2021); (4) Establish an innovation and research hub for AI in education: Creating a dedicated research and innovation lab within CETID could foster interdisciplinary collaboration among students, educators, and technologists. Such a hub can support research on localized EdTech solutions, AI-enhanced learning platforms, and emerging innovations relevant to African contexts (UNESCO, 2023); and (5) Strengthen regional and global collaboration: BUSE should continue its engagement with networks like UNESCO-IICBA, UNESCO-ICHEI, and SADC education bodies. Regional collaboration can facilitate knowledge exchange, policy learning, and joint research initiatives, contributing to the broader transformation of higher education systems in Africa.

In conclusion, BUSE's case illustrates that meaningful digital transformation is possible, even within resource-constrained environments. With the right policy frameworks, partnerships, and strategic investment, the university can continue to evolve into a regional leader in AI and digital education, preparing learners not just for today's demands but for the future of work and society.

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Chapter 15

An Innovative AI Ecosystem: Forging Excellence in Teaching, Learning, Research, and Technology Integration

Maurice Nkusi[20]

Introduction

Namibia University of Science and Technology (NUST), initially named the Polytechnic of Namibia, which emerged from Namibia's post-independence vision, attained university status in 2015. The university is firmly committed to playing a prominent role in national development in the fields of science, technology, and innovation. The university has four major Faculties: the Faculty of Computing and Informatics, the Faculty of Engineering and the Built Environment, the Faculty of Commerce, Human Sciences and Education, and the Faculty of Health, Natural Resources and Applied Sciences. Three of them offer exclusively STEM programmes. In recent years NUST has significantly increased access to quality education, increasing the number of students enrolled by over 45 percent between 2019 and 2024 and established regional campuses to target underserved communities across the country.

In this dynamic and fast-changing educational environment, Artificial Intelligence (AI) is revolutionising education in a way that the teacher-student's role is transformed to teacher-AI-student (UNESCO, 2024). Being cognisant of this crucial shift, NUST has initiated the integration of AI in its teaching, learning, and research architecture, and is responding to the changing teaching and learning patterns of academic staff and students. This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), examines in broad terms the deployment of AI at NUST, focusing on strategic interventions, pedagogic innovations, as well as ethical considerations, all geared towards producing a futuristic teaching and learning environment with human agency and excellence at its core.

Challenges

The initiative of NUST in introducing AI and the transformation of teaching and learning responds to significant educational challenges such as a need to strengthen learning facilitation; transition away from largely summative assessments to including innovative formative assessment; availability of better-quality content that supports better learning experiences for students; and the overcoming of infrastructural difficulties such as uneven internet availability in some areas. To address these challenges, NUST has adopted a layered strategy, involving not only the acquisition of AI competency among staff and students but also innovative pedagogical models and strong ethical guidelines.

The advent of AI in higher education, especially at NUST, has brought challenges in different dimensions, especially in teaching and learning modalities. While the cognitive processes of Bloom's Taxonomy reiterate facilitating learning from lower-order thinking and moving to higher-order thinking, the reality looks different now. During class observation exercises, we observed that when the lecturer was teaching in class by strengthening a solid foundation through theory, students were busy, at the same time consulting with AI tools of their choice, researching the creation aspect based on what the lecturer was busy with. This observation taught us something: while teachers are busy with facilitating learning following the progressive cognitive processes of Bloom's Taxonomy (Figure 1), students are busy with the upside-down of this taxonomy, at the same time (Figure 2). There is a great challenge with the reality on the ground. The two Figures below illustrate what is happening. They show two different ways of learning approaches in the era of the AI revolution. The teacher's approach suggests starting with the conventional cognitive processes, but students may be interested in getting to the solution as quickly as possible, even though they may not understand it. In such a situation, students may rely completely on AI, and the results will be that students will become less critical and creative thinkers, and their ability to solve problems will decrease over time due to the loss of independent reasoning (Stuchlíková and Weis, 2024). This is what NUST and any educational institution should help prevent. The question is: How can academic staff be innovative to respond to this challenge and respond to students' learning preferences that may be contrary to best practices?

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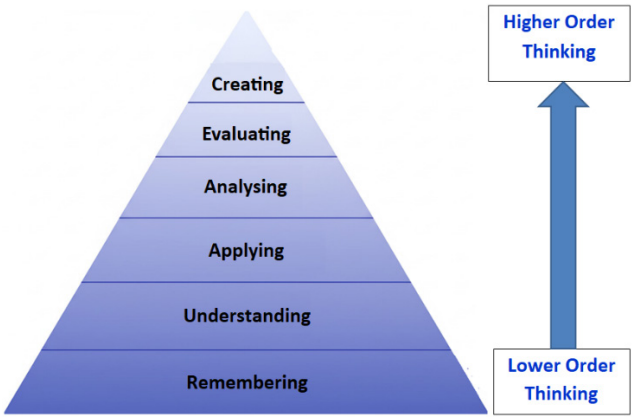
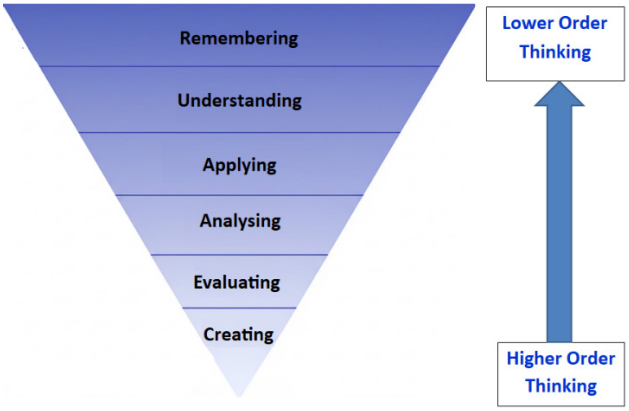
Figure 1: Teacher's Vision on Facilitating Learning



Source: Author.

Figure 2: Students' Perspective – The Opposite



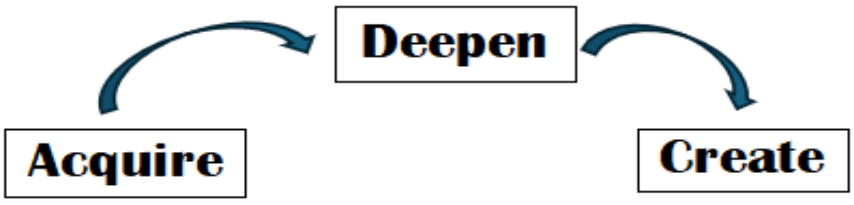
Source: Author.

NUST acknowledges that academic staff are the main users of AI in education, not least as the designers and enablers of students' learning and as guardians of safe and ethical practices in an AI-rich environment. Faculty at NUST have significant agency in the implementation and use of AI, as first adopters, and as a substantial force shaping how AI becomes a part of teaching, learning, and the ethical measures that support it (Pisica et al., 2023). Although many educators see an opportunity for AI to improve education, concerns over ethics, academic integrity, and the lack of institutional support and training are pervasive. The vision of the university is for academics to achieve a high level of understanding of the technical, ethical, and pedagogical implications of AI, and for them to be equipped with the authority that allows them to remain in control rather than surrender to AI, while never caving in to the AI revolution.

Cultivating AI Competencies for Teachers

To empower its academic staff, NUST emphasises the development of key AI competencies. Drawing inspiration from frameworks like UNESCO's AI competency framework for teachers (UNESCO,2024), NUST established cognitive pathways to equip academic staff with the necessary knowledge, skills, and values resulting in desired competencies, which are categorised across three progression levels, such as Acquire, Deepen, and Create, as shown in Figure 3.

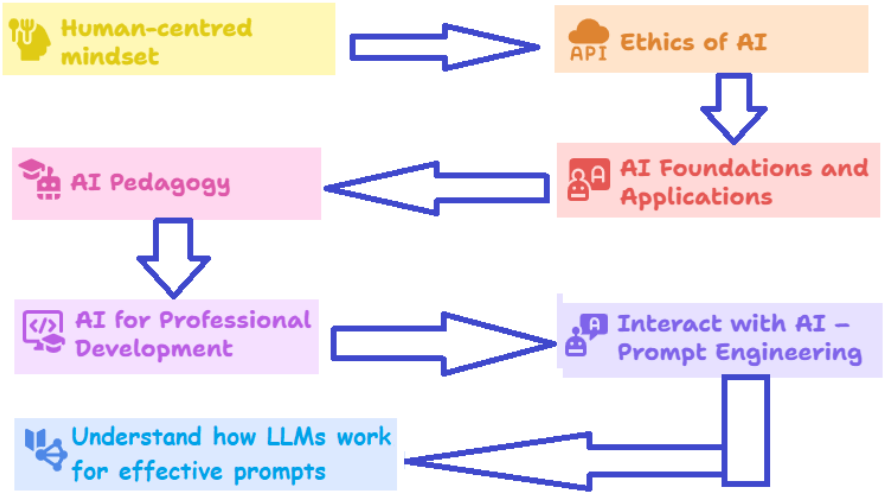
Figure 3: Three Levels of AI Competency for Teaching Staff at NUST



Source: Provided by the author.

These levels hold seven competencies that NUST considers critical, including a human-centred mindset that involves cultivating a critical understanding that AI development and deployment must be human-led, recognising that the decisions made by AI creators have profound implications for human autonomy and fundamental rights, and thereby prioritising human flourishing and agency. The ethics of AI requires developing a foundational grasp of typical ethical challenges. This encompasses the protection of human rights, personal data, human agency, and linguistic and cultural diversity, and involves internalising core principles such as do no harm, proportionality, non-discrimination, sustainability, human determination, transparency, and explainability, alongside a commitment to respecting data privacy and intellectual property rights.

Figure 4: Cognitive Pathways to Competency Acquisition.



Source: Provided by the author.

Foundations and applications of AI include acquiring conceptual knowledge about what AI entails, how AI models are trained, and the roles of data and algorithms in this process, as well as understanding the general categories of AI technologies and critically assessing the suitability and limitations of specific AI technologies for educational use (Shrivastava, 2024). In addition, competency must allow academics to appraise AI tool outputs for verification purposes, including being able to understand the inner workings of large language models (LLMs), such as the mathematical underpinnings and the training processes.

NUST created an online self-paced course to prepare academic staff and even students with advanced understanding of the mathematical and algorithmic underpinnings of LLMs, such as tokenisation, embeddings, attention mechanisms, and optimisation methods (Hu et al., 2024). Through this online course, academic staff and students can better understand how LLMs process and generate text through the interpretation of these concepts, which in turn would allow them to design more targeted prompts through prompt engineering techniques in order to obtain desired results. In addition, probability distributions and entropy help academics to design prompts that balance predictability and creativity. Furthermore, knowing embeddings and attention mechanisms should help them in structuring queries, taking into account contextual relationships. Much enhanced understanding of how LLMs function will provide academic users with the means to adjust their prompts for clarity, relevance, and effect, maximising their potential to use LLMs efficiently in educational contexts.

The next competency, AI pedagogy, is the intentional strategic use of AI to support teaching practice, which relies on individual academics being able to understand and use the pedagogical potential of AI in their discipline, for example to create lesson plans, facilitate learning, set assessment tools, and be able to manage the risks involved. In doing so, it means integrating AI into student-centred approaches to foster engagement, support differentiated learning, and enhance teacher-student interactions, ultimately aiming to promote student empathy, critical thinking, and problem-solving skills.

Another competency is the implementation of AI in professional development interventions where academic staff are encouraged and trained to explore and utilise AI tools to enhance their own professional growth and reflective practices. A study conducted in 2024 highlighted challenges the academic staff were facing. As shown in Figure 5, many staff had challenges with using AI for engaging students, content development, conducting research, and most concerning for their satisfaction with AI outputs. This competency allows academics to assess their learning needs and personalise their learning pathways. Furthermore, interacting with AI through prompt engineering involves developing

the specific skill of crafting effective inputs (prompts) to guide AI systems in generating desired outputs, as discussed in the next section, thereby improving the accuracy, relevance, and usefulness of those outputs.

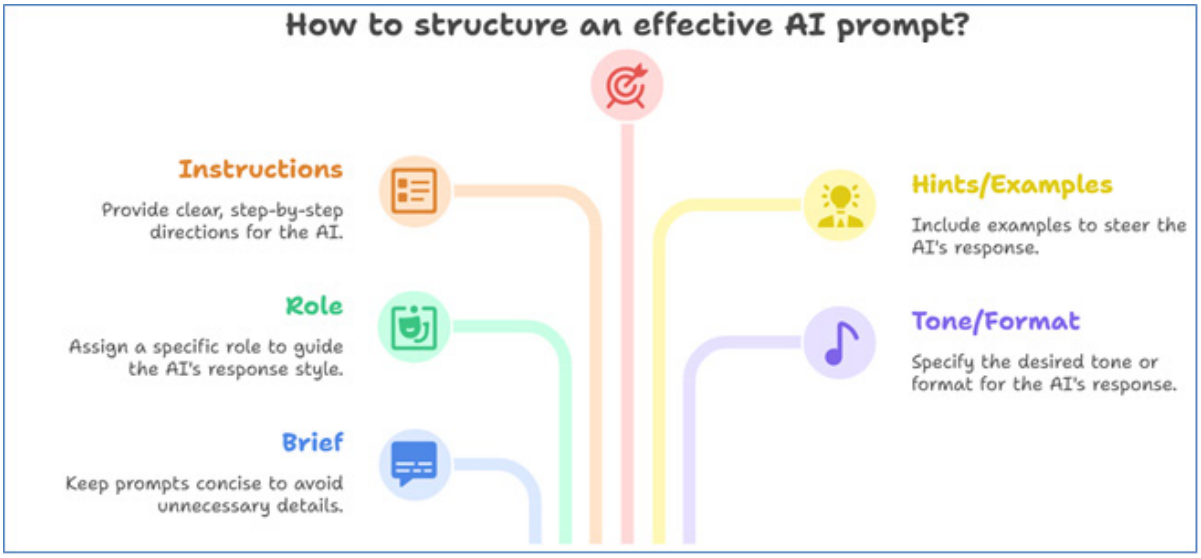
Table 1: Results from a Survey Among Academic Staff on their Confidence Levels in Using AI (%)

Confidence Level	Use AI for Student Engagement	Use AI for Content Development	Use AI for Research	I am satisfied with the AI Output
Strongly agree	2	0	7	1
Agree	6	9	10	4
Neutral	18	10	12	9
Disagree	21	15	16	20
Strongly disagree	4	13	6	19
No answer	2	6	2	0

Source: Provided by the author.

NUST's commitment to these competencies is exemplified through one of its self-paced online courses named "AI Innovative Implementation in Higher Education: A Hands-On Course for Academics". The course was designed to respond to gaps as shown by the data in Table 1. This is an intensive course that trains academic staff to judiciously and responsibly integrate AI across a large area of academic work, from teaching and learning to content development and assessment. The responses from the study confirmed that lecturers were not interacting effectively with the AI tools used due to limitations in understanding of how to create effective prompts to get quality information from AI. In the self-paced online course, prompt engineering is discussed comprehensively, and the techniques for prompting are well explained and demonstrated. One of the frameworks used is the BRIGHT methodology illustrated in Figure 5.

Figure 5: BRIGHT Framework to Create Effective Prompts



Source: Provided by the author.

Even if those concerns can be dismissed, they are far from the only challenges regarding the deployment of AI as the pros and cons of using AI need to be considered, and mitigation of possible biases must be established. To this end, AI user guidelines or handbooks should also be developed to ensure students' awareness of the importance of carefully checking AI outputs and maintaining academic integrity. For now, an AI policy is under development at NUST together with a handbook. Academic staff are trained to conceptualise the personalised learning experiences that leverage AI to provide improved, carefully thought-out feedback aimed at fostering students' critical assessment skills. The good news is that the learning management system (LMS) used at NUST, namely MOODLE, has AI capabilities that permit the implementation of adaptive and personalized features. Finally, NUST is designing future learning models that actively embrace inclusive, agency-empowering co-design processes involving AI for capability augmentation and saving time to increase productivity. Furthermore, the self-paced online courses address ethical and hazard considerations like data privacy and AI-made errors (e.g., hallucination), fostering fundamental AI literacy for both academic staff and students.

Empowering Students with Generative AI Competencies

NUST also developed comprehensive support mechanisms for students to acquire competencies in utilising Generative AI tools for academic success through a self-paced online course entitled "Effective Learning in a Complex World: Integrating Generative AI for Student Academic Success.". This course aims for students to appreciate the multifaceted nature of learning in higher education and the increasing demands for significant contributions to industry solutions. The course explains what Gen AI is in the context of quality learning. It defines the AI potential applications, benefits, and challenges, including how to generate effective prompts to improve AI-generated responses. It also trains students to use AI as a tutor to achieve academic success and enhance their learning experiences, and introduces students to identify the capabilities and inherent limitations of generative AI tools, distinguishing between AI's support functions and indispensable human thinking skills like critical, creative, reflective, and innovative thinking. The course also introduces the concept of AI ethical usage, critically describes the appraisal techniques of AI tools' outputs, introduces techniques for recognising and mitigating risks (such as hallucination), and ensuring academic integrity by properly acknowledging AI use and differentiating personal work. Finally, the course introduces other AI tools that students can use to identify the accuracy of the obtained information from AI, such as Consensus AI, SciSpace AI, etc., and it leverages generative AI tools to enhance key academic skills, including reading comprehension, effective notetaking, academic writing, presentation, and general study skills/ The hope is that students can make informed decisions about selecting and employing diverse generative AI tools for specific learning tasks, while managing study time and acknowledging potential inaccuracies, biases, or outdated information in AI outputs.

Pedagogical Innovation: The Flipped Classroom and Flexible Hybrid Learning

NUST's pedagogical method is also strengthened by its "Flexible Hybrid Learning Model," which addresses the issues of the lack of opportunity for higher-order thinking practice during traditional lectures and during virtual sessions. The flipped classroom is used to free up one to two hours of in-class time to encourage students to engage in active learning, leading to higher-order thinking skills required to develop competencies. In doing so, students apply, analyse, evaluate, and create based on Bloom's Taxonomy of cognitive processes in the classroom under the teacher's supervision. Lower order thinking skills, such as remembering and understanding, are addressed outside of the classroom through recorded lectures.

A productive flipped classroom demands high-quality, well-organised learning resources that are synchronously accessible by all students from a student-centred perspective, including with attention to equity, diversity, and inclusiveness. This model enables instant feedback from lecturers during in-class activities, which is beneficial for learning. To produce quality learning materials, NUST utilises the backward design approach, which is intentional and supported by generative AI for learning materials to align with curriculum requirements and directives. In addition, for students with poor internet coverage, offline materials are developed for them, having the same look and feel as the online resources. In doing so, issues related to students without good internet access are resolved, especially for those in areas with poor networks and students with special needs. The lectures are recorded in advance and shared through the eLearning Management System (LMS) and recordings are loaded on the offline version of the course. This strategic choice of making content available offline is vital for inclusivity, as highlighted by the university's goal of ensuring access to quality education "everywhere, at all times."

Conclusion

NUST is driving an innovative higher education agenda by making AI an integral part of the way staff and students work, communicate, and collaborate. It takes a holistic approach and builds fundamental AI competencies for academic staff and students to become more than users of, but also critical consumers and ethical practitioners with AI. Through innovative pedagogies, such as the flipped classroom, academics optimise face-to-face time to engage students in higher-order thinking. In addition, materials developed for a flipped classroom can be transformed into offline resources for students without internet access. By ensuring that critical, creative, reflective, and innovative thinking skills are preserved, human agency and quality learning in an AI-infused space will be valuable to the planet. Finally, the university emphasises a responsible use of AI to reinforce ethical AI for academic integrity.

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Chapter 16

Digitalization and AI in Botswana's Higher Education: A Case Study for Botswana Open University

Freeson Kaniwa and Gbolagade Adekanmbi [21]

Introduction

The rapid digitalization of higher education across the African continent presents transformative opportunities to expand access, enhance quality, and address persistent equity challenges. As African nations pursue knowledge-based economic development, the integration of Information and Communication Technologies (ICTs) and Artificial Intelligence (AI) has become a strategic imperative. The COVID-19 pandemic accelerated this transformation, with 1.6 billion students globally affected, forcing massive shifts to digital platforms and demonstrating the resilience of open universities through flexible online teaching and educational technology innovations (Tau and Adekanmbi, 2021).

This chapter is part of an exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025). It provides a case study of digital transformation and AI integration at Botswana Open University (BOU), positioning its experience within the broader narrative of African higher education's response to the digital age. By examining national policy drivers, institutional implementation phases, and pedagogical innovations underway, the chapter seeks to illuminate critical success factors, persistent challenges, and ethical considerations inherent in embedding AI within a public African Open and Distance Learning (ODL) context. BOU, established in 2017 with a national mandate to democratize access to learning, serves a diverse population through ODL methodologies that are particularly relevant for AI applications in personalized support and automated interaction (Adekanmbi et al., 2022; Kaniwa and Adekanmbi, 2026).

Botswana's Digital and Higher Education Landscape

Botswana's commitment to digital transformation is encapsulated in the Maitlamo National Information and Communication Technology (ICT) Policy launched in 2007 which serves as the blueprint for transitioning the nation into a globally competitive knowledge and information society (Republic of Botswana, 2007). The policy established objectives for creating an enabling ICT industry environment, providing universal service access, and positioning Botswana as a regional ICT hub. According to recent data, Botswana has achieved mobile cellular penetration exceeding 160 percent, providing broad reach for mobile learning strategies (African Development Bank, 2025a). However, internet connectivity presents challenges; while fiber optic infrastructure links major urban centers, reliable and affordable "last mile" connectivity remains a barrier for students in remote areas. Government initiatives such as the Nteletsa II project have expanded high-speed internet access to district centers, recognizing connectivity as essential for educational and economic development. Despite progress, the cost of data and devices, coupled with inconsistent power supply in certain regions, necessitate multimodal delivery strategies to ensure inclusivity and equity in access. Table 1 presents key national digital indicators:

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Table 1: National Digital Infrastructure and Education Indicators for Botswana

Indicator	Value/Status	Source	Implication for Higher Education
Mobile cellular penetration	>160%	African Development Bank (2025a)	Broad reach for mobile learning strategies
Rural internet connectivity	Limited last-mile access	African Development Bank (2025a)	Need for offline/low-bandwidth solutions
Education investment (% GDP)	~9%	African Development Bank (2025a)	Strong government commitment
Overall unemployment rate	27.6%	Central Statistics Office (2024)	Skills-aligned programs critically needed
Youth unemployment (15-35)	38.2%	Central Statistics Office (2024)	Urgent demand for relevant education
NEET youth	39.9%	Central Statistics Office (2024)	Opportunity for flexible pathways
National literacy rate	87%	Central Statistics Office (2024)	Strong foundation for digital literacy

Source: Data compiled by the authors from multiple government and development partner sources for 2024.

Note: NEET = Not in Education, Employment, or Training.

Botswana invests approximately 9 percent of its GDP in education, with a 2024/2025 budget allocation of P28.60 billion (USD 2.1 billion) to education and training (African Development Bank, 2025a; Adekanmbi, 2025). The tertiary education sector includes the University of Botswana, Botswana International University of Science and Technology, Botswana Open University, Botswana University of Agriculture and Natural Resources and various colleges, including education or health institute and technical ones. Despite huge investments, the country faces significant challenges including graduate unemployment, partly driven by skills mismatch (Human Resource Development Council [HRDC], 2025). HRDC's Priority Skills Report emphasizes the need for proactive upskilling and education reforms to shift from "education for employment" to "education for job creation, research, and innovation" amid slow economic growth.

The higher education sector is guided by the HRDC and the Botswana Qualifications Authority (BQA), which ensure programs meet rigorous standards. The HRDC 2025 report emphasizes rapid skills evolution driven by technological advancements, the Fourth Industrial Revolution, AI, automation, globalization, and environmental crises (HRDC, 2025). Vision 2036, Botswana's long-term development strategy, envisions the country as "an educated and informed nation" and "a prosperous, productive and innovative nation" (Republic of Botswana, 2016). BOU, due to its mandate, is critical for flexible, technology-enabled programs that can help achieve this goal. The university plays a crucial role as Botswana's only dedicated open university, similar to the University of South Africa (UNISA), the Open University of Tanzania, or the Zimbabwe Open University, all within the Southern African Development Community (SADC) (Tau and Adekanmbi, 2021).

Botswana Open University: Institutional Profile

BOU's history is rooted in the transformation of the former Botswana College of Distance and Open Learning (BOCODOL) from a college to a university. This shift was formalized through an Act of Parliament passed in July 2017 and commencing December 1, 2017 (Parliament of Botswana, 2017), marking a major milestone that enabled the institution to independently develop, offer, and accredit university-level programs through ODL methodologies (Adekanmbi, 2025; Tau and Adekanmbi, 2021). This transformation represented a strategic national investment in expanding access to higher education and supporting Botswana's transition toward a knowledge-based economy.

BOU's primary mandate is the democratization of access to higher education and training, specifically targeting out-of-school youth and working adults. The institution is designed to break down geographical and socio-economic barriers by providing flexible learning environments, enabling students to study at a pace and place convenient to them (Adekanmbi et al., 2022). This mission is critical in addressing national skill shortages and supporting Botswana's Vision 2036 aspirations. In the University's academic structure, there are five schools: Education; Business and Management Studies; Social Sciences; Science and Technology; and Graduate Studies. While headquartered in Gaborone, the University has a national reach through regional campuses and study centers outside Gaborone in Francistown, Palapye, Maun, and Kang. This geographic distribution is essential for providing localized student support and facilitating blended ODL delivery across the country. BOU's governance structure, led by the University Council and Senate, oversees quality assurance and strategic direction (Adekanmbi, 2025).

As of 2024-2025, BOU offers 20 active programs spanning certificates, diplomas, bachelor's degrees, and postgraduate qualifications, with an additional 13 programs at various stages of BQA approval. The November 2024 graduation recorded 1,479 graduates, of which 81.3 percent were women, highlighting both institutional reach and the need for enhanced male student engagement. The university relies on approximately 1,200 part-time tutors to supplement academic programs, reflecting both operational scale and human resource constraints (Adekanmbi, 2025).

Digital Transformation Journey

BOU's journey began in the pre-digital era when its predecessor, BOCODOL, relied predominantly on traditional correspondence education. Learning materials were print-based, and interactions between tutors and students were managed through postal service or infrequent face-to-face tutorials. This model, while effective in extending reach, was characterized by slow feedback loops and limited student engagement (Adekanmbi et al., 2022). Initial ICT integration efforts focused on establishing a basic online presence and implementing rudimentary student information systems. The strategic shift began with formal adoption of a Learning Management System, primarily Moodle, which became the central hub for course delivery. This transition necessitated significant investment in bandwidth and digitization of print resources, marking the first major phase of digital transformation. Implementation faced infrastructure challenges, particularly in regional centers, requiring network capacity upgrades. The core challenge in ODL environments was ensuring equitable platform access regardless of location or device availability.

The COVID-19 pandemic forced a rapid acceleration of digital adoption, affecting educational institutions globally (Tau and Adekanmbi, 2021). BOU scaled up video conferencing tools (Google Meet and Microsoft Teams) for synchronous tutorials and developed comprehensive offline learning packages for students with limited connectivity. Despite challenges, BOU demonstrated resilience similar to other open universities worldwide, maintaining operations and enrolment through flexible digital resources. This period cemented the importance of multimodal content delivery, ensuring materials are available in various formats (text, audio, video) across diverse platforms (Adekanmbi et al., 2022). The pandemic served as a catalyst that compressed years of gradual digital transformation into months of intensive innovation and adaptation. BOU's current digital infrastructure reflects a systematic evolution from correspondence-based delivery to a sophisticated hybrid model. Table 2 illustrates the institutional digital transformation timeline.

Table 2: BOU's Digital Transformation Timeline

Phase	Period	Key Technologies	Primary Focus	Major Achievements
Phase 1: Pre-Digital Era	Pre-2010	Print materials, postal service, face-to-face tutorials	Traditional correspondence	National reach via print
Phase 2: LMS Adoption	2010-2019	Moodle LMS, student portals, basic online resources, email	Digital infrastructure foundation	Established online presence, basic digitization
Phase 3: COVID-19 Catalyst	2020-2022	Google Meet, Microsoft Teams, multimodal content, offline access through BOU App	Emergency remote teaching, continuity	Rapid digital adoption, maintained operations
Phase 4: AI Integration	2023-Present	AI chatbots, predictive analytics, generative AI, automated assessments	Personalization, efficiency, innovation	Flexible Hybrid Learning Model, AI pilots

Source: Authors.

The current infrastructure includes a robust Moodle-based Learning Management System serving as the central platform for course delivery and student interaction; comprehensive e-learning platforms and tools integrated with the LMS for content delivery, assessment, and communication; digital libraries and resource access providing students with electronic journals, e-books, and open educational resources; and enhanced student support systems including online helpdesks, virtual advising, and digital communication channels (Adekanmbi, 2025). The BOU Mobile App with offline capability extends access to students in low-connectivity areas, while the Integrated Technology System (ITS) manages student data, recruitment, and assessment processes. An Online Ethics Clearance System streamlines research approval workflows, and an Online e-Counselling platform (currently piloting) provides mental health and academic support services.

AI Integration in Teaching, Learning, and Research

BOU's AI integration focuses on systems that enhance personalization, streamline administration, and improve learning outcomes at scale, aligning with broader trends in African higher education digitalization (Kaniwa and Adekanmbi, 2026). Table 3 summarizes key AI initiatives. The AI-powered chatbot handles high volumes of routine queries, providing instant, localized support to geographically dispersed learners. This 24/7 availability directly counters ODL's delayed feedback challenge; a critical innovation in African ODL contexts where human resource constraints limit traditional support services. Automated assessment and feedback systems in selected quantitative programs offer immediate diagnostic feedback on practice exercises, preventing misconception compounding and accelerating learning. The implementation aligns with UNESCO observations on AI's potential to enhance educational quality in resource-constrained African contexts.

Table 3: AI-Enhanced Systems and Applications at Botswana Open University

AI Application	Primary Function	Target Users	Implementation Status	Expected Impact
AI-Powered Chatbot	24/7 student support for research ethics clearance	All students conducting research	Implementation phase	Reduced response time, decreased administrative workload
Automated Assessment & Feedback	Immediate diagnostic feedback on exercises and formative assessments	All students	Pilot phase (quantitative programs)	Faster feedback loops, reduced tutor workload
Predictive Learning Analytics	Identify at-risk students through engagement data analysis	All enrolled students	Active implementation	Early intervention, reduced attrition
Generative AI for Content	Assist in creating teaching materials (MCQs, case studies, summaries)	Academic staff across schools	Pilot phase	Accelerated content production
Academic Integrity Tools	Plagiarism detection using Turnitin	All students submitting assessments	Fully operational	Maintained academic standards
BOU Mobile App	Offline-capable mobile access to materials	All students, especially low-connectivity areas	Operational with enhancements	Improved accessibility
Online Ethics Clearance	Research ethics approval workflow management	Researchers, graduate students	Operational	Streamlined research processes
Integrated Technology System	Student data management, recruitment, assessment	Administrative staff, students	Operational	Enhanced data management

Source: Authors.

Predictive learning analytics help assess student engagement data from the LMS (login frequency, resource consumption, quiz scores) to identify at-risk students. By predicting potential attrition, the system flags students to academic advisors, enabling personalized learning pathways and timely intervention (Kaniwa and Adekanmbi, 2026). Academic staff leverage generative AI tools to create varied teaching materials, including generating multiple-choice questions, drafting case studies, and summarizing texts, accelerating content production and freeing instructional designers for higher-level pedagogical design. Academic integrity tools like Turnitin employ sophisticated AI and machine learning for automated plagiarism detection, supporting faculty in ensuring work authenticity while educating students about academic honesty (Adekanmbi, 2025).

BOU has prioritized comprehensive capacity building focusing on staff and students. Staff training initiatives include participation in seminars, colloquia, and professional development programs on AI-enhanced pedagogy, digital content creation, and learning analytics (Adekanmbi, 2025). The institution collaborates with international partners including the Commonwealth of Learning and UNESCO for capacity building in digital and AI literacy. For students, BOU is developing AI literacy components across programs to prepare graduates for technology-driven workplaces and enable effective use of AI-enhanced learning tools. This dual focus recognizes that successful AI integration depends not only on technological infrastructure but also on human capacity to leverage these tools effectively.

BOU is also pioneering a Flexible Hybrid Learning Model that strategically combines asynchronous and synchronous learning to maximize cognitive outcomes, operationalizing the flipped classroom approach within the ODL

environment (Kaniwa and Adekanmbi, 2026). This innovation positions BOU alongside global open universities demonstrating convergence of campus-based and distance education modalities while maintaining core ODL strengths like home-based study and resource scalability (Tau and Adekanmbi, 2021). The model's asynchronous phase focuses on lower order thinking skills (Remember and Understand; Bloom's Taxonomy Levels 1-2). Students engage with pre-recorded micro-lectures, self-paced readings, quizzes, and AI-enhanced practice exercises on their schedules. This component is optimized for low-connectivity environments, leveraging offline materials critical for African contexts with infrastructure challenges. The synchronous phase reserves live tutor-facilitated sessions for higher-order thinking skills (Apply, Analyze, Evaluate, Create; Bloom's Levels 3-6). Tutors facilitate online sessions dedicated to collaborative problem-solving, case discussions, peer interaction, and immediate feedback on complex tasks.

This innovative strategy ensures that limited high-value synchronous time is dedicated to critical thinking and deeper engagement, while AI and self-paced materials handle foundational content acquisition (Kaniwa and Adekanmbi, 2026). The model exemplifies how open universities can pioneer AI-enhanced pedagogies for underserved populations while maintaining educational quality (Tau and Adekanmbi, 2021). Adaptive learning technologies personalize content delivery based on individual student performance and learning pace, while AI-enhanced student support strategies including chatbots provide immediate assistance for routine queries, freeing human advisors for complex student needs.

Challenges and Constraints

Despite significant progress, BOU's digital transformation faces persistent challenges typical of ODL institutions in resource-constrained environments. Infrastructure limitations remain the most significant impediment with inconsistent access to reliable, affordable high-speed internet the greatest barrier to equitable digital learning. Power supply issues and fluctuations, particularly in remote areas, necessitate expensive backup solutions straining operational budgets. The cost of data and devices creates accessibility barriers for students, requiring ongoing institutional support (African Development Bank, 2025a).

Digital literacy gaps persist between faculty and student digital skills and rapidly evolving demands of digital pedagogy and AI tools. Gaps are particularly pronounced among older or rural populations, requiring continuous, differentiated training and support. Resistance to change and cultural barriers manifest as some faculty express anxiety regarding perceived threats of AI to pedagogical autonomy and concerns about academic dishonesty. Overcoming traditional instructional models requires sustained institutional leadership to foster a culture embracing technology and innovation.

Financial sustainability concerns are substantial, as capital costs for procuring, licensing, and continuously upgrading advanced AI software and maintaining LMS infrastructure are considerable. Challenges are compounded by dwindling budget allocations affecting tutor payments, government non-financing of BOU students (unlike other tertiary institutions), and insufficient funds to expand programs to regional campuses (Adekanmbi, 2025). Developing sustainable funding models beyond ad-hoc project funding is critical.

Quality assurance in AI-augmented learning also presents evolving challenges. Ensuring academic rigor and fairness of assessments in AI-enhanced environments requires clear, robust policies on AI-generated content in student submissions and quality monitoring of AI-driven feedback systems. Academic integrity and plagiarism concerns are amplified by generative AI tools, necessitating updated policies distinguishing between legitimate AI assistance and academic misconduct. Data privacy and ethical considerations become paramount as BOU leverages predictive analytics and personalized learning systems. Establishing clear data governance policies and ensuring compliance with national and international privacy standards is essential for maintaining student trust.

Opportunities and Strategic Initiatives

BOU's strategic AI integration presents several high-impact opportunities aligned with national priorities and global open university trends. AI-driven personalized learning offers potential to move beyond simple adaptive quizzing to truly individualized learning pathways, dramatically improving student success rates by tailoring content delivery and pacing to unique student profiles, ultimately reducing historically high ODL dropout rates. This aligns with HRDC's emphasis on innovation in education to address skills mismatches and graduate unemployment (HRDC, 2025).

Enhanced administrative efficiency through automation can reallocate human resources to complex, high-touch support functions like academic advising and counselling, significantly improving student experience. Expansion of

access to underserved populations is possible through AI-powered tools facilitating localized education delivery via automated content translation into local languages and robust mobile device support, reaching remote communities previously excluded by language or connectivity barriers. This directly supports Vision 2036's goal of fostering a globally competitive yet locally relevant workforce (HRDC, 2025; Republic of Botswana, 2016).

Research collaboration and innovation opportunities position BOU to become a regional leader in AI in African ODL through internal initiatives and strengthened international collaborations, creating a pipeline of locally relevant, evidence-based innovations (Tau and Adekanmbi, 2021). Public-private partnerships offer strategic opportunities, as telecommunications partnerships can subsidize student data costs while EdTech collaborations provide access to cutting-edge AI tools and expertise, easing financial burden on the public institution (African Development Bank, 2025a). Regional leadership in ODL and AI integration can be established by successfully piloting ethical and scalable AI solutions, enabling BOU to establish a pioneering model for other SADC institutions.

In terms of recommendations, to ensure sustainable and equitable advancement of digitalization and AI integration, BOU should focus on several strategic priorities. Policy development priorities should immediately formalize a comprehensive, consultative institutional AI Policy outlining ethical guidelines, data security protocols, and clear rules for acceptable AI use by staff and students and establish an AI-Ethical Review Board for vetting new technologies, monitoring algorithmic bias, and ensuring systems align with the university's equity and quality mission. Infrastructure investment needs also require prioritizing dedicated, long-term funding for stable electricity supply (including solar integration at regional centers) and strategically targeting investment toward low-cost, high-reach mobile-based learning solutions. Capacity building strategies should move beyond basic training to establish continuous communities of practice for faculty, fostering peer-to-peer learning and incentivizing development of AI-enhanced, contextually relevant courses. Quality assurance mechanisms should develop robust policies for handling AI-generated content in student submissions, implement regular monitoring of AI-driven feedback systems, and strengthen collaboration between quality assurance and technology-enhanced learning units. Sustainable funding models should explore new financing avenues including dedicated national funding for digital infrastructure, leveraging public-private partnerships for technical services, and developing revenue-generating initiatives.

Conclusion

Botswana Open University's engagement with digitalization and AI represents a critical case study of how ODL institutions in Africa are adapting to global technological shifts. Established in 2017, BOU's strategic focus on leveraging AI to mitigate inherent distance learning challenges; student isolation, delayed support, high attrition; holds immense promise for enhancing educational equity and attainment (Kaniwa and Adekanmbi, 2026; Tau and Adekanmbi, 2021). The institution's methodical, policy-driven approach to AI integration, supported by strong national policy frameworks, positions it as an emerging model for personalized, accessible learning in the region (African Development Bank, 2025a; Republic of Botswana, 2016). While infrastructure constraints, financial limitations, and capacity gaps exist, BOU's investments in AI-powered student support, predictive analytics, and the Flexible Hybrid Learning Model demonstrate commitment to innovation. Success requires sustained investment in infrastructure, continuous capacity building, robust ethical frameworks, and cultivation of sustainable partnerships. BOU's alignment with national priorities for economic diversification and the HRDC's paradigm shift toward "education for job creation, research, and innovation" positions the institution as a key catalyst for Botswana's transformation into a knowledge-based economy (HRDC, 2025).

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Part III

Guidance Documents

Chapter 17

Digital Competencies and Artificial Intelligence: Guidance Documents with a Focus on Teachers and Education Systems

Temechegn Engida and Quentin Wodon[22]

Introduction

Digitalization and AI have the potential to profoundly transform higher education in Africa by upgrading teaching, learning, research, and administration (e.g., Chisom et al., 2023). But there are also risks. Unfortunately, many teachers in Africa, including those teaching in higher education institutions (HEIs), do not have the skills needed to fully take advantage of the opportunities that digitalization and AI may provide, and there is concern that digitalization and especially AI may in the relatively short-term lead to job losses among knowledge workers, including higher education teachers and other professionals.

This chapter, which is part of a broader exploratory study on digitalization and the use of AI in African higher education (Wodon, 2025), introduces some of the key concepts and frameworks from UNESCO and the African Union that can help thinking about both the challenges and opportunities represented by digitalization and the use of AI in higher education, including for teachers. The realization of the importance of digitalization (and to a lesser extent AI) in education was heightened by the COVID-19 pandemic, with countries worldwide expanding online and distance education in basic or higher education. In sub-Saharan Africa, however, lack of connectivity to the internet made it more difficult to implement distance learning.

In the future, internet access, digitalization, and the use of AI are likely to be essential for (i) reducing access and equity disparities in higher education (e.g., through digital tutoring systems, classrooms, and learning platforms); (ii) improving quality and relevance (e.g., through adaptive learning platforms); (iii) preparing students for the labor market (e.g., readiness for the fourth industrial revolution and the use of AI at work); (iv) improving efficiency and institutional administration (e.g., through use of digital tools and AI for admissions, scheduling, and student support through chatbots, predictive analytics, and automated systems); and (v) supporting research and innovation (e.g., through AI-driven analytics, natural language processing, and machine learning to solve challenges across sectors)[23]. And yet, notwithstanding these promising areas, African higher education must first overcome challenges from poor digital infrastructure, low digital literacy, limited funding, and a lack of strong policies and ethical guidelines.

These challenges have been well recognized. A decade ago, the Continental Education Strategy for Africa 2016-25 (CESA 16-25) included as one of its 12 strategic objectives harnessing the capacity of ICT to improve access, quality and management of education and training systems (African Union Commission, 2015). This objective identified six action areas, although they did not refer specifically to digitalization in higher education nor AI, which was still in development stage at the time, even if the need to "f*ormulate policies for ICT integration in education and training"* and *"build ICT capacities of learners and teachers to take full advantage of the potentials of technologies"* were recognized. Various organizations focusing on teacher issues in Africa also recognized the importance of building ICT skills among teachers[24]. At the country level as well progress is also being made. In anglophone Africa for example, Kenya (Kenya Ministry of Education, Science and Technology, undated), Nigeria (National Open university of Nigeria, undated), Rwanda (Ministry of Education, 2017), and Uganda (Ministry of Education, 2016) have all adopted some form of ICT standards or guidance for teachers.

22 The authors are with UNESCO's International Institute for Capacity Building in Africa (IICBA). The opinions expressed in this article are those of the authors only, and need not represent the views of UNESCO, its Executive Board members, the countries they represent, or UNESCO IICBA and the members of its Governing Board.

23 See for example Chisom et. al. (2023).

24 For example, UNESCO's International Institute for Capacity Building in Africa (IICBA) proposed ICT-enhanced Teacher Standards for Africa as a strategy for strengthening teacher development or ICTeTSA (UNESCO IICBA, 2012, with the first author of this chapter as lead author of the study). The development of ICTeTSA was based on an analysis of practices and policies in 18 African countries. The report suggested six standards, each expanded into three core competencies (knowledge, skills and attitude) spread over 4 hierarchical levels (emerging, applying, infusing and transforming). Three consultative workshops were held with African Union member states through regional economic communities, namely ECOWAS, SADC, and together EAC, ECCAS and IGAD.

The new Continental Education Strategy for Africa 2026-35 (CESA 26-35) recently approved by the African Union also recognizes the importance of digital skills (African Union Commission, 2025). As discussed in more details in Chapter 3 of this study, digital competencies and AI are mentioned in three different areas of CESA 26-35: (i) Higher Education and TVET is one of six areas of focus for CESA 26-35; (ii) Promoting 21st century and labor market skills, including for ICT/AI and STEAM, is one of three objectives for pre-primary to secondary education; and (iii) digitalization and AI are mentioned as one of three mega-trends that education systems in Africa must adapt to. Out of necessity, the discussion of these topics is limited in CESA 26-35 to keep the strategy at a readable length, but more detailed work could be conducted as part of CESA 26-35 implementation to flesh out the implications of digitalization and AI for (higher) education.

In what follows, the aim is two-fold: (i) to introduce key concepts and frameworks that can be useful for discussing digitalization and the use of artificial intelligence, with a focus on teachers including in higher education; and (ii) to outline some of the new strategies that have been adopted at the level of the African Union in those areas. The next two sections are devoted to those two aims. A brief conclusion is as follows.

Digital and AI Competencies for Teachers

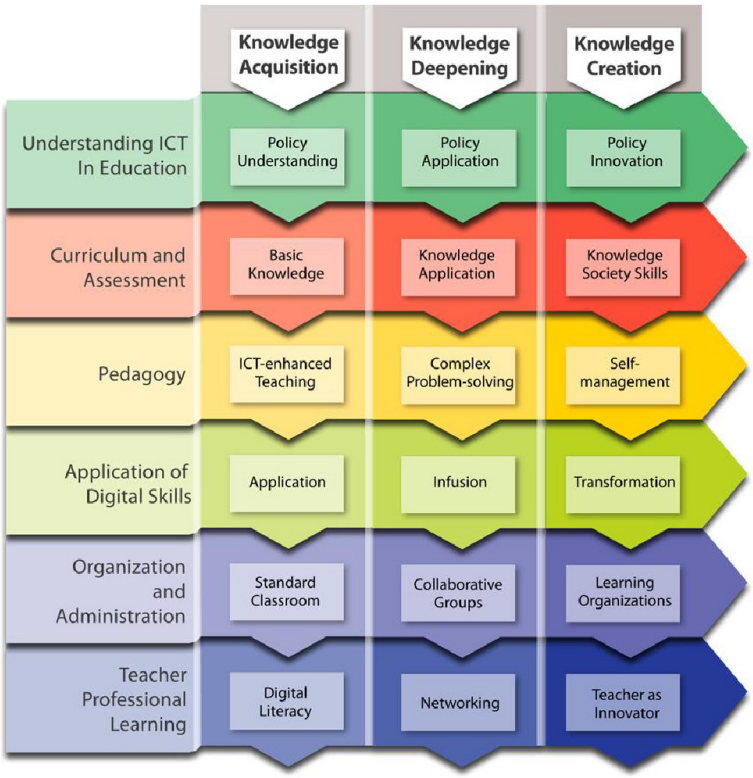
What does it mean to be digitally competent? Digital competency can be understood as the confident, critical, and responsible use of digital technologies for work, education, and social engagement. Technical proficiency, cognitive skills, and ethical considerations are all integrated into the multifaceted concept of digital competency. Various frameworks emphasize different elements, such as critical thinking (UNESCO, 2018a), sociocultural participation (Jenkins, et al., 2009), and practical skills (Carretero, et al, 2017; International Society for Technology in Education (ISTE, 2016). UNESCO (2018a) views digital competency as part of digital literacy, involving among others technical skills (using devices, software), cognitive skills (evaluating information, critical thinking), and social-emotional skills (digital citizenship, ethics). Similarly, Skov (2016) defines digital competency as "a combination of knowledge, skills and attitudes with regards to the use of technology to perform tasks, solve problems, communicate, manage information, collaborate, as well as to create and share content effectively, appropriately, securely, critically, creatively, independently and ethically."

Once digital competency is defined, digital competency frameworks can be used, as noted among others by Mattar et al. (2025), as structures of linked competences that can help assess and develop the digital competency of individuals in specific professions, such as teachers, but also more broadly citizens. Several such frameworks have been proposed. The International Society for Technology in Education (ISTE) published standards for students, educators, education leaders, and for coaches. The European Commission's Digital Competency Framework for Citizens (DigComp 2.0) is another framework, which has been used as a reference to test individuals' competencies. Also relevant is the European Framework for Digital Competency of Educators—DigCompEdu which outlines how to support the development of educator-specific digital competencies with 22 competencies organized under six areas (Punie and Redecker, 2017).

UNESCO's Digital Literacy Global Framework builds on the work carried at the European Union, but with a stronger emphasis on developing countries. It was based among others on: (i) a synthesis of existing regional, national and sub-national frameworks to identify competences; (ii) an analysis of digital literacy competencies demonstrated in information and communications technology (ICT) use in major socio-economic sectors, with a focus on developing countries; (iii) an in-depth consultation to seek expert views on the appropriateness and use of a global framework; and (iv) an online consultation to seek experts' feedback. The framework is structured around seven competency areas: (1) Devices and software operations; (2) Information and data literacy; (3) Communication and collaboration; (4) Digital content creation; (5) Safety; (6) Problem-solving; and (7) Career-related competences. Also from UNESCO, the ICT Competency Framework for Teachers or ICT-CFT (UNESCO, 2018b) has special relevance for this study. Drafted in 2008, it consists of six domains and three levels of knowledge acquisition (see Figure 1)[25].

25 Other frameworks suggested for teachers include the Technological Pedagogical and Content Knowledge (TPACK) Framework (Mishra and Kohler, 2006). Shulman (1997) introduced the concept of pedagogical content knowledge (PCK) as the ways content, pedagogy, and knowledge of learners are blended into an understanding about how particular topics to be taught are represented and adapted to learners' characteristics, interests, and abilities. TPACK was developed to account for the rise of educational technologies (Mishra and Koehler, 2006).

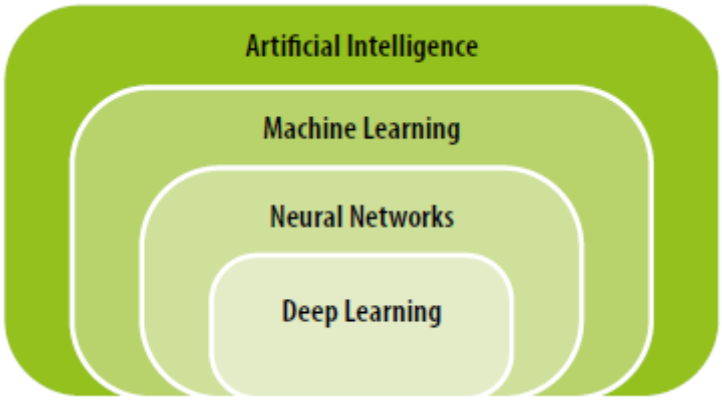
Figure 1: UNESCO's ICT Competency Framework for Teachers



Source: UNESCO (2018b).

What about AI? The understanding of AI has evolved over time. One of its earliest conceptions by Turing (1950) started with the question "Can machines think?" Turing viewed AI as systems that can mimic human intelligence to the point of being indistinguishable from humans. Subsequent conceptions include those of Newell and Simon (1976) who view AI as something that models human cognition to understand intelligence - using computational models to replicate human thought processes, Mitchell (1997) who emphasized learning from data rather than hard-coded rules, referring to deep learning, neural networks, and statistical learning, and Bonabeau et al. (1999) who viewed AI as systems as exhibit intelligence through decentralized, emergent behaviors building on genetic algorithms, ant colony optimization, and swarm robotics. Russel and Norvig (2022) view AI as the study and design of intelligent agents that act rationally to achieve goals. And according to UNECO (2021), in a simple way, AI is the big goal, which means intelligent machines, while machine learning is a way to achieve AI (to teach machines to learn from data), neural networks are a type of algorithm within machine learning inspired by the brain and deep learning is a technique using large (deep) neural networks to learn complex patterns, often from vast amounts of unstructured data (Figure 2). Referring to the Beijing consensus on AI in education, UNESCO (2021) calls for support to higher education and research institutions in developing or enhancing courses and research programs to foster local AI talent. It also recommends fostering the development and growth of local AI expertise, minimizing the influence of vested interests on its development.

Figure 2: Relationships between AI, Machine Learning, Neural Networks and Deep Learning



Source: UNESCO (2021).

As for digital competency, once AI and related competencies are defined, frameworks can guide policy and specific interventions. For teachers, UNESCO's AI Competency Framework for Teachers or AI-CFT (2024) is especially relevant. Arguing that AI has transformed the traditional teacher-student relationship into a teacher-AI-student dynamic, UNESCO (2024) states that this shift requires a re-examination of teachers' roles and the competencies they need in the AI era. Analysis suggests that only seven countries have developed AI frameworks or programs for teachers. The AI-CFT is closely aligned with the ICT-CFT mentioned above. It includes five aspects or competencies and the progression levels (Figure 3).

Figure 3: UNESCO's AI Competency Framework for Teachers

Aspects	Progression		
	Acquire	Deepen	Create
1. Human-centred mindset	Human agency	Human accountability	Social responsibility
2. Ethics of AI	Ethical principles	Safe and responsible use	Co-creating ethical rules
3. AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
4. AI pedagogy	AI-assisted teaching	AI–pedagogy integration	AI-enhanced pedagogical transformation
5. AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

Source: UNESCO (2024).

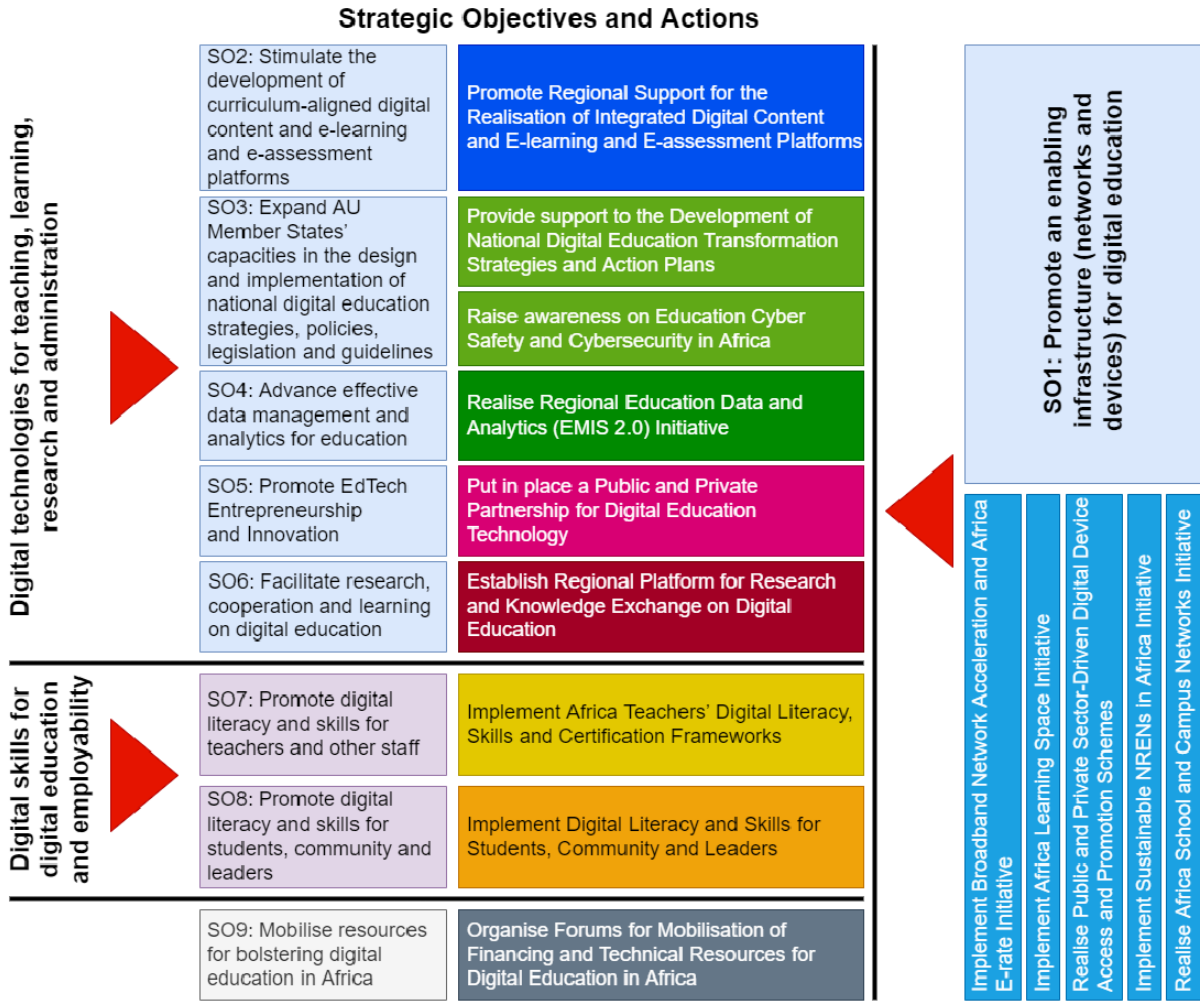
Strategies and Initiatives from the Africa Union

Given the focus on this study on Africa, it is also useful to briefly review frameworks with a focus on Africa. Recognizing both the potential and challenges of digitalization and AI in Africa, the African Union (AU) has developed several relevant strategies and initiatives, including (i) the Digital Education Strategy and Implementation Plan or DESIP (African Union Commission, 2022); (ii) the Continental Artificial Intelligence Strategy or CAIS (African Union Commission, 2024). Another important initiative, the Pan African Virtual and E-University or PAVEU, is not discussed here but is the focus of Chapter 5 in this study.

Digital Education Strategy and Implementation Plan

DESIP encourages using digital technologies for improving learning experiences while closing educational disparities and developing future workforce-ready African youth. As shown in Figure 4, DESIP consists of nine strategic objectives around three main areas of focus: (i) Digital technology appropriation in education – accelerating the adoption of digital technologies for teaching, learning, research, assessment and administration; (ii) Education in digital technologies for digitally empowered citizens/ for the digital economy and society – strengthening digital literacy and skills for all, especially for teachers and students; and (iii) Building the capacities of Member States in digital infrastructure (devices and networks). Infrastructure development is a key strategic objective of the digital education strategy.

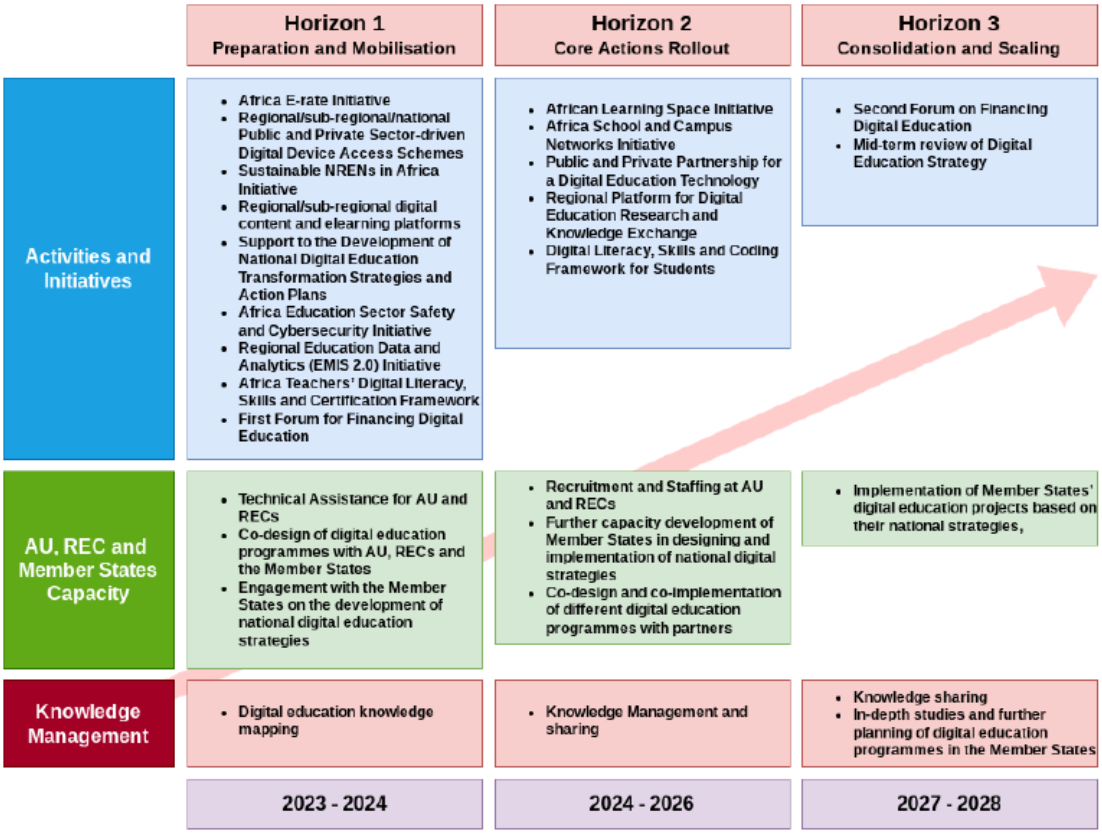
Figure 4: Digital Education Strategy and Implementation Plan of the African Union



Source: African Union Commission (2022).

DESIP has a five-year timeframe with 14 proposed actions (see Figure 5). The strategy is holistic, covering a broad spectrum of digital education components. It also aligns with the African Union's broader vision, Agenda 2063. Stakeholders include Member States, the private sector, development partners, and regional economic communities. Yet many challenges remain, including uneven infrastructure, digital skills gaps, lack of funding, and limited digital content development and localization in Member States.

Figure 5: DESIP's Strategic Objectives and Proposed Actions



Source: UNEVOC (2022), adapted from African Union Commission (2022).

Continental Artificial Intelligence Strategy

The African Union recently adopted a Continental AI Strategy (CAIS) with five focus areas as shown in Figure 6: (i) Harnessing AI's benefits for people, institutions, the private sector, and countries while promoting the competitiveness of the private sector; (ii) Addressing risks associated with the use of AI, with attention to governance, inclusion and diversity, human rights, and gender equality among others, considering African contexts, cultures, and values; (iii) Accelerating Member States' capabilities in infrastructure, AI talent acquisition and skills, and innovation and research for AI development; (iv) Fostering regional and international cooperation and partnerships to develop AI capabilities; and finally (v) Stimulating public and private investment in AI at the national and regional levels.

Taken together, these focus areas and related actions provide a comprehensive framework to leverage AI for sustainable development. In so doing, the African Union also acknowledges the importance of higher education in promoting AI innovation, research, and workforce development, with building AI skills in higher education requiring integrating AI into computer science and mathematics education and establishing advanced research in various AI domains, considering both technical and ethical aspects. Apart from discussing the need for AI education and skills development and related curriculum reforms in universities, the strategy also highlights the need to establish Centers of Excellence in AI and partnerships between academia, industry, and governments. At the higher end, the strategy stresses that specialized courses should allow college students to develop sophisticated programming using complex algorithms.

Figure 6: CAIS Framework

Source: African Union Commission (2024).

Recognizing the fact that limited infrastructure is a big challenge, the strategy proposes to have strong universities that produce breakthrough ideas and tools that can be readily commercialized and scaled, and an educated population that produces entrepreneurs and engages in debates about AI. The AI strategy also argues that, even though the benefits of AI remain high for the continent, recent developments indicate a growing concern about the AI divide between Africa and the rest of the world due to the lack of high-quality and large datasets, lack of high-performance computers (HPC), and talent capabilities that are critical for AI development and use. This implies that there is a need for high-performance computing (HPC) infrastructure in universities to support AI research. In conclusion, the AI strategy gives due emphasis on research, innovation and ethical issues with respect to AI in higher education. Building capability for AI is one of its five focus areas with a direct link to the functions of HEIs. At the same time, while CAIS has strengths, issues remain. For example, Abiero et al. (2024) suggest three issues: (i) Risks from a multiplicity of strategic documents given a separate AUDA-NEPAD White Paper and AI Roadmap for Africa; (ii) Risks from a lack of stakeholder engagement in the preparation of the strategy, including the most vulnerable; and (iii) Risks related to lack of resources and limits of global cooperation.

Conclusion

Tertiary education in Africa and elsewhere is at a crossroads, confronting new challenges and opportunities related to the revolution in digitalization and use of AI which are likely to transform how students learn, faculty teach, and institutions operate (Molina and Medina, 2025). As noted among others by Yidana, et al. (2023), challenges faced by higher education institutions include inadequate preparation and readiness to adopt online modes of teaching and learning, which are themselves due to lack of infrastructure as well as limited competencies among teachers. Frameworks exist however to guide policies. This chapter introduced a few of these frameworks with a focus on teachers and outlined recent continental strategies and frameworks adopted by the African Union. This includes DESIP and CAISU, both of which harness the transformative potential of digitalization and AI for African education.

As we close this chapter, ethical challenges should not be forgotten. To address these challenges, UNESCO (2022) published recommendations on ethics of AI with 11 policy action areas. The eighth area focuses on education and research and emphasizes the need to (i) promote AI ethics education, (ii) strengthen interdisciplinary research, (iii) build capacity for responsible AI development, and (iv) ensure inclusivity and lifelong learning. Simply put, Policy Action 8 emphasizes that education and research are about educating people on how to build AI responsibly and understand its implications for society. It aims to produce a globally engaged citizen with AI literacy and with ethical awareness along with a research ecosystem that prioritizes human wellbeing and fundamental rights in the pursuit of AI innovation.

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4 QUALITY EDUCATION

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