Digital Transformation of Higher Education in Sub-Saharan Africa: Challenges and Opportunities in Advanced Digital Skills

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Abstract. The ongoing era of digital transformation has significantly altered the societal and economic landscape, profoundly impacting every aspect of daily life. This transformation has also highlighted the urgent need for both specialized digital skills and advanced digital skills. This paper addresses the gap in specific domain digital skills, advanced digital skills and the capacity for digital skills development within higher education institutions in sub-Saharan Africa. To this end, the average percentage of access to and attainment of tertiary education in sub-Saharan Africa is compared with that of the European Union. Furthermore, the capability for advanced skills development is assessed by comparing universities in sub-Saharan Africa with those in the European Union. The results indicate a significant gap in advanced digital skills between sub-Saharan Africa and the European Union. Additionally, higher education institutions in the European Union are more proficient in teaching, research, and industrial engagement than those in sub-Saharan Africa. Finally, a framework that emphasizes the use of technology, economics of sharing, and collaboration has been proposed to bridge this gap.

Keywords: digital transformation, digital Skills, advanced digital skills, sub-Saharan Africa, Nano-degree, Micro-degree, economics of sharing

1. Introduction

Digital transformation refers to the comprehensive utilization, integration, and adoption of information and communication technology (ICT) and digital technologies across all aspects of society. This transformation aims to accelerate economic development, enhance efficiency, improve services, advance education and skills development, and promote environmental sustainability, among other areas. Digital skills are regarded as one of the fundamental pillars of a country's digital transformation strategy and play a crucial role in the digitization process (Bouarar, Mouloudj, & Mouloudj, 2022). To this end, digital skills are essential for the development, adoption, and integration of information technology across all sectors of society, including education (Elfahal & Saeid, 2021; Suleiman, Yahya, & Tukur, 2020). Digital skills are also essential for both society and workers to fully leverage technology. Consequently, the enhancement of digital skills has become a crucial component of national digital transformation strategies in developing countries (Heavin & Power, 2018; Nazari & Musilek, 2023). Based on the European Union and the ITU skills frameworks, digital skills are broadly categorized into two types: skills for life, which are essential for everyone to fully engage in the digital society and economy, and skills for work. The latter are further divided into three categories: general digital skills (which enable individuals to be productive in various contemporary work environments), domain-specific digital skills (which are necessary for the development of specific sectors, such as healthcare, agriculture, energy, finance...etc) and advanced digital skills (Commission, Directorate-General for Education, & Culture, 2019; I. T. Union & Development, 2024). At this time of global implementation and acceleration of the Sustainable Development Goals (SDGs), these skills are unfortunately inequitably distributed, with significant gaps in many regions of the world. Developed countries exhibit a higher percentage of skilled individuals, while underprivileged nations—primarily in sub-Saharan Africa—lack both domain-specific and advanced digital skills altogether (Hakizimana, 2021). Unlike general digital skills, domain-specific and advanced digital skills require a strong foundation in higher education for effective development (E. Union, 2021,

2023). Acknowledging the role of the higher education system in facilitating the transition to the digital transformation era, considerable attention in the literature has been devoted to examining the challenges associated with transforming higher education institutions (Akour & Alenezi, 2022; Gkrimpizi, Peristeras, & Magnisalis, 2023). An excellent summary of the challenges and impacts associated with the digital transformation of higher education has been comprehensively reported (Benavides, Tamayo Arias, Arango Serna, Branch Bedoya, & Burgos, 2020; Gkrimpizi, Peristeras, & Magnisalis, 2024; Trevisan, Eustachio, Dias, Filho, & Pedrozo, 2024). Furthermore, the university currently plays an active role in supporting, sustaining, developing, and promoting innovation in society alongside other partners (Blass & Hayward, 2014; Peter, Andrea, & Pavel, 2023). Therefore, digital transformations in higher education influence knowledge sharing across all institutional functions, including teaching and learning, governance and operations, research, and community engagement (Kumar, Cook, Fayed, Kinik, & Maisuradze, 2024). Thus, today, the digital transformation of the higher education system has become indispensable for enhancing teaching, learning, and university operations in order to advance the digital skills ecosystem (Akour & Alenezi, 2022; Alenezi, Wardat, & Akour, 2023; Javed & Alenezi, 2023). Comprehensive reports that, sub-Saharan Africa is experiencing a significant digitization gap compared to the developed world (Bhorat, Signe, Asmal, Monnakgotla, & Rooney, 2023). Inside this digitization gap, there exists a significant skills gap, which is even more pronounced for specific domain skills and advanced skills (Parry, Orkoh, Jansen van Rensburg, & Viviers, 2024). This work explores the gap in specific domain digital skills, advanced digital skills and skill development capabilities in Sub-Saharan Africa by identifying challenges and seeking opportunities. The remainder of this paper is organized as follows: Section 2 outlines the methodology; Section 3 highlights the domain-specific and advanced digital skill gaps, as well as the issues surrounding digital skill development in Sub-Saharan Africa. Section 4 presents the proposed hypothetical solution framework, and Section 5 concludes the paper.

2. Methodology

To emphasize the gaps in domain-specific digital skills, advanced digital skills and the capabilities required for effective digital skills development necessary for successful digital transformation, two World Bank development indicators were utilized. The first is the School enrolment, tertiary (% gross) which measures the percentage of ratio of total enrolment at the tertiary level, regardless of age(Bank, 2024). This indicator serves as a proxy to emphasize the overarching issues in the region. The second indicator is the Educational attainment, at least completed short-cycle tertiary, population 25+, total (%) (cumulative), which measures the average percentage of the population aged 25 and older who have attained or completed short-cycle tertiary education (Bank, 2025). Both indicators were employed to evaluate tertiary education attainment in the Sub-Saharan Africa region compared to the European Union and East Asia & Pacific regions. Furthermore, to assess the quality of education, three performance indicators from the Times higher education rankings institute were utilized to evaluate and compare the learning and innovation ecosystem capabilities in Sub-Saharan Africa and European Union. The indicators used are teaching or the learning environment (which comprise Teaching reputation, Staff-to-student ratio, Doctorate-to-bachelor's ratio, Doctorates-awarded-to-academic-staff ratio, and Institutional income) Research environment (which comprise Research reputation, Research income and Research productivity), and Industry engagement (which comprise income and patents)(Education, 2021). For the assessment, the average teaching, Research environment and Industry engagement is calculated for top ranked universities from different countries in European Union and Sub-Saharan Africa.

3. Advanced digital skill gap and skills development Problem

Figure 1 compares the average percentage tertiary school enrollment rates gross in sub-Saharan Africa with those in the European Union, East Asia and the Pacific region, and the global average. In 2019 and 2021, the average enrollment rates for sub-Saharan Africa were 9.3% and 9.4%, respectively. These figures are significantly lower than the global averages of 39.1% in 2019 and 41.4% in 2021, the European Union averages of 74% in 2019 and 77.8% in 2021, and the East Asia and Pacific region averages of 50% in 2019 and 56.48% in 2021. This is just proxy to the research problem.

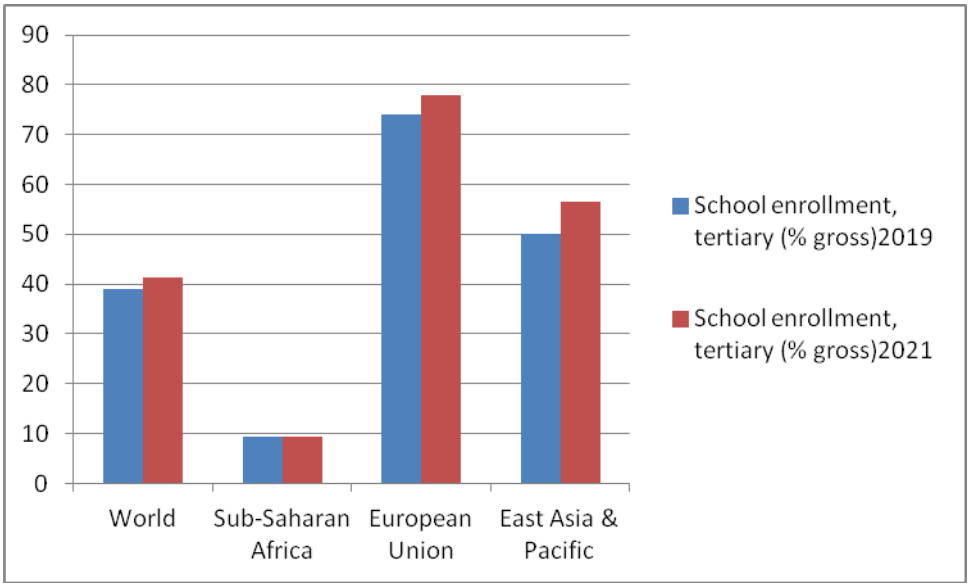

Figure 1.Comare the average of the indicator (School enrolment, tertiary (% gross)) of the Sub-Saharan Africa, European Union, the world and the East Asia and Pacific regions for the years 2019 and 2021 respectively.〔source: World Bank Development Data〕

Figure 2 compares the average percentage of the population aged 25 and older who have attained or completed at least short-cycle tertiary education in sub-Saharan Africa and the European Union. It is evident that the average percentage in sub-Saharan Africa (8%) is significantly lower than that of the European Union (34%). Analyzing Figures 1 and 2 together underscores the disparity in specific domain digital skills and advanced digital skills in sub-Saharan Africa and the challenges associated with adapting or even re-skilling e to meet the required standards with minimal effort, which is crucial for achieving successful digital transformation.

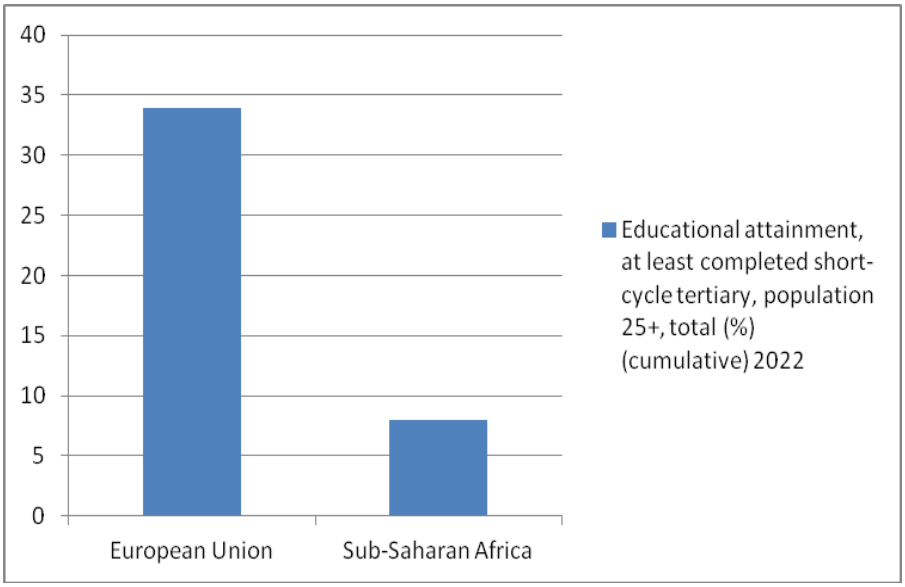

Figure 2. Compare the indicator (The average Educational attainment, at least completed short-cycle tertiary, population 25+, total (%) (cumulative) 2022) of sub-Saharan Africa and European Union〔source of data: world bank Development Data〕.

A sample of Sub-Saharan African countries used to calculate the average percentage of the population aged 25 and older who have attained or completed at least short-cycle tertiary education includes Benin, Rwanda, Burkina Faso, Botswana, Ghana, Guinea-Bissau, Nigeria, and Senegal. In contrast, the sample of European Union countries comprises Germany, Denmark, Spain, Estonia, Finland, France, Greece, and Hungary.

Figure 3 compares the calculated averages for Teaching, Research Environment, and Industry Engagement among the top-ranked universities in the European Union and Sub-Saharan Africa for the year 2025. The results indicate that, in the area of Teaching and Learning, the European Union's score is 69.12, while Sub-Saharan Africa's score is significantly lower at 24.02. In terms of Research Environment, the European Union achieves a

score of 79.02, compared to Sub-Saharan Africa's score of 22.84. For Industry Engagement, the European Union's score is 96.55, whereas Sub-Saharan Africa's score is 41.44. Overall, the indicators show that Sub-Saharan Africa scores considerably lower than the European Union. This result highlights the weaknesses and institutional gaps in the development of specific domain digital skills and advanced digital skills within Sub-Saharan African institutions, particularly in comparison to those in the European Union.

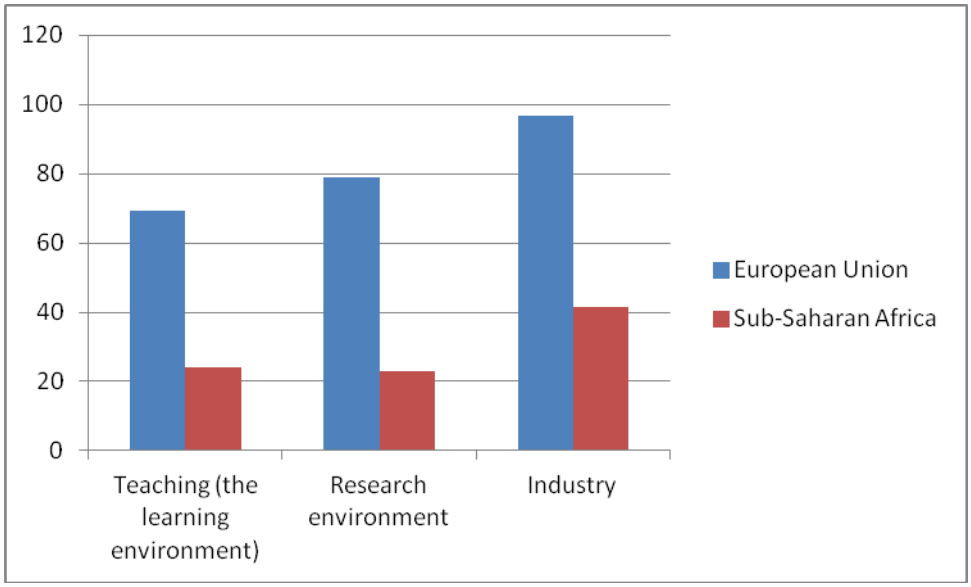

Figure 3 illustrates the calculated averages for Teaching, Research Environment, and Industry Engagement among the top-ranked universities (selected from differet countries) in the European Union in 2025, compared to the corresponding averages for the top-ranked universities in the Sub-Saharan Africa region (also selected from different countries.) for the same year.(source of data: Time for higher Education ranking)

Universities from the European Union that were considered for calculating averages in Teaching, Research Environment, and Industry Engagement among the Times top-ranked institutions include ETH Zurich, the Technical University of Munich, PSL Research University Paris, Delft University of Technology, Karolinska Institute, and KU Leuven. In contrast, the universities selected from Sub-Saharan Africa are the University of Cape Town, Covenant University, the University of Cape Coast, Botswana International University of Science and Technology (BIUST), and Jimma University.

4. The Proposed Hypothetical Solution framework

Based on the issues identified in Section 3, this section presents the proposed solution framework to address the highlighted skills gaps and support institutional weaknesses. Figure 4 illustrates the main pillars and supporting elements of the proposed solution, which are elaborated upon in the following subsections.

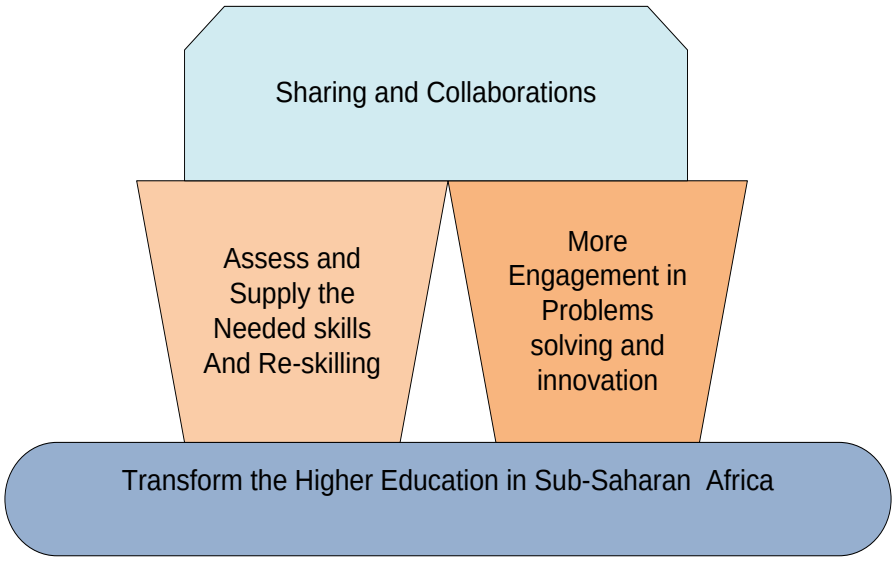

Figure 4. shows the Proposed advanced skills gap Solution Framework

4.1. Transforming the higher education Institutions

The central pillar of the proposed solution for higher education in the region is to transform the functions (teaching/Learning, governance/ operations research and community engagement) enhance cost-effectiveness, improve outcomes that align with current needs, and ensure success in a complex and interconnected world characterized by rapid changes. Additionally, it seeks to make education accessible to all, including disadvantaged and vulnerable groups.

4.2. Sharing and collaborations

The second pillar is to establish and implement robust frameworks within the country and across sub-Saharan Africa, as well as beyond the region, to maximize the benefits of technology and the economics of sharing and collaboration. The sharing framework should encompass various elements, such as infrastructure, technology and tools, teaching methods, and best practices among others. Conversely, the collaboration frameworks can take multiple forms, including partnerships within universities, with civil society, and with other organizations. For instance, collaborations within universities may involve training, research, and running micro- and nano-programs, among others. Collaboration with society and the community may involve supporting innovations across various sectors, promoting and utilizing technology, as well as information and communication technology (ICT), for problem identification and resolution. Additionally, it can enhance communication between the community and other stakeholders regarding the issues that need to be addressed.

4.3. Evaluating and Providing the needed Skills and Re-skilling

With the aid of a thorough assessment of specific domain digital skills, advanced digital skills and foresight into the near future, university programs can be adjusted and tailored to meet emerging needs. Furthermore, micro- and nano-degree programs can be introduced to address the demands for rapid skill acquisition and re-skilling needs (A nano-degree is a certified online educational program that helps students develop specialized skills in areas such as computer science, data Science, programming, artificial Intelligence, etc. while micro-degrees are considered certificates that require a lower level of commitment.)

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4.4. Engagement in Problem solving and Innovation

In the era of digital transformation, the university community's engagement and innovation must leverage the advantages of technology, trends, and opportunities.

5. Conclusions

This paper highlights the gap in advanced digital skills and the capacity for digital skills development among higher education institutions in sub-Saharan Africa. To this end, the average percentage of access to tertiary education in sub-Saharan Africa is compared with the average percentage of access to and attainment of tertiary education in the European Union. Furthermore, the capability for advanced skills development is evaluated by comparing universities in sub-Saharan Africa with those in the European Union. The Result indicates a significant gap in advanced digital skills between sub-Saharan Africa and the European Union. Finally, a framework that emphasizes the use of technology, sharing, and collaboration is proposed to bridge this gap.

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