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Digital Transformation for Educational Development in Sub-Saharan Africa

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Abstract

Digital transformation holds significant promise for revolutionizing education in Sub-Saharan Africa (SSA). This paper examines the challenges of digital transformation in education in the SSA region. We observed that the challenges are multifaced, including infrastructure deficits, access and equity barriers, digital literacy gaps, financial constraints, policy challenges, and regulatory barriers. To overcome these challenges, the paper offers some recommendations that can help the SSA countries to unlock the transformative power of digital technologies to advance education, empower learners, and build a brighter future. Amongst other, the paper suggests that stakeholders must adopt an integrated approach to infrastructure development, promote equitable access and inclusion, invest in capacity building and skills development, localize educational content, mobilize financial resources, enact policy and regulatory reforms, and foster collaborative partnerships.

Keywords: Digital Transformation, Education, SSA, Sustainability.

1. Introduction

Sub-Saharan Africa (SSA) is known for its variety of cultures, languages, and socio-economic situations, which bring both challenges and possibilities in the field of education[1]. SSA is home to more than one billion individuals in 48 nations[2], and encounters considerable discrepancies in education, such as restricted entry to high-quality education, insufficient infrastructure, and uneven allocation of resources. Despite advancements in increasing primary education availability in the past years, the SSA region still faces many complex issues that pose significant challenges including poor literacy rates, high dropout rates, and an ongoing skills gap[3]. All these have constrained the region's ability to fully realize the advantages of digital transformations.

Digital transformation has become a hopeful solution to tackle these issues and create new possibilities for education in SSA[4]. Digital technologies such as mobile devices, internet connectivity, software, and online learning platforms have the capacity to transform teaching and learning methods, increase availability of educational resources, and enhance learning results[5]. Nonetheless, to fully tap into the possibilities of digital transformation in education demands a united push to conquer obstacles and utilize technology advantages efficiently.

There is an increasing significance of promoting information sharing, skill development and engagement in digital innovation for education in the SSA region. Collaboration among governments, schools, civil society, and businesses is crucial for promoting joint efforts, utilizing resources, and enhancing the effectiveness of digital education projects[6]. The dynamic and multifaceted

[1] Appiah, E. K., Arko-Achemfuor, A., Adeyeye, O. P., & Toerien, D. F. (2018). Appreciation of diversity and inclusion in Sub-Sahara Africa: The socioeconomic implications. *Cogent Social Sciences*, *4*(1).

[2] Wikipedia (2024). Sub-Saharan Africa. Retrieved from https://en.wikipedia.org/wiki/Sub-Saharan_Africa.

[3] UNESCO. (2020). Global Education Monitoring Report 2020: Inclusion and education: All means all. Paris, France: UNESCO.

[4] Zickafoose A, Ilesanmi O, Diaz-Manrique M, Adeyemi AE, Walumbe B, Strong R, Wingenbach G, Rodriguez MT, Dooley K. Barriers and Challenges Affecting Quality Education (Sustainable Development Goal #4) in Sub-Saharan Africa by 2030. *Sustainability*. 2024; 16(7):2657. https://doi.org/10.3390/su16072657

[5] Bates, A. W. (2019). Teaching in a Digital Age: Guidelines for Designing Teaching and Learning (2nd ed.). Vancouver, BC: Tony Bates Associates Ltd.

[6] Consultative Group to Assist the Poor (CGAP). (2021). Digital Finance in Sub-Saharan Africa: A Business and Investment Landscape. Washington, DC: CGAP.

landscape in SSA is shaped by the meeting point of digital transformation and educational development[7].

This paper examines the multifaceted challenges of digital transformation in education including infrastructure deficits, access and equity barriers, digital literacy gaps, financial constraints, policy challenges, and regulatory barriers. This article explores the main challenges hindering digital transformation in SSA, including inadequate infrastructure, digital inequalities, and regulatory hurdles. The paper identifies and addresses these challenges to educational development through an expository and content analysis of the important literature. The article offers developing policies, strategies, and interventions that show how digital technologies can improve education outcome in the region. The study proposes comprehensive recommendations to address them.

2. Literature Review

Challenges of Education in SSA

Education in SSA countries has encountered numerous challenges over time because of a mix of historical, socio-economic, and political factors. Before the emergence of digital transformation, the region encountered many obstacles that prevented equal access to top-notch education. A significant challenge was the severe shortage of infrastructure, including schools, classrooms, and educational resources. UNESCO[8] noted that with about 61 million children out of school, the SSA region has the most children not engaged in primary school worldwide in 2018. The crowded classrooms, inadequate teacher preparation, and obsolete teaching techniques often resulted in a diminished quality of education. Many students encountered difficulties in acquiring fundamental literacy and numeracy skills, leading to higher rates of dropout and subpar academic performance. The socio-economic inequalities exacerbated the education gap, presenting challenges for marginalized groups like girls, rural communities, and children with disabilities[9].

[7] UNESCO Institute for Statistics (UIS) (2022). Data on Information and Communication Technologies (ICT) in education (https://uis.unesco.org/en/topic/information-and-communication-technologies-ict).

[8] UNESCO. (2019). Global Education Monitoring Report 2019: Migration, displacement, and education. Paris, France: UNESCO.

[9] UNESCO. (2021). Global Education Monitoring Report 2021: The Hidden Crisis: Armed conflict and education. Paris, France: UNESCO.

The lack of appropriate educational resources for specific communities hindered effective learning outcomes. Textbooks and educational materials often lacked in availability, cultural sensitivity, were outdated, preventing students from effectively engagement. Language barriers posed significant challenges since most educational resources were in colonial languages instead of the indigenous languages spoken by many students[10]. Several issues with institutions and their management have influenced the education system resulting in rampant corruption, finance mismanagement and inadequate accountability. Insufficient governance systems have impeded efforts to improve both the accessibility and quality of education. Furthermore, assessing the effectiveness of education policies and interventions was difficult because of insufficient data collection and monitoring systems, hindering evidence-based decision-making[11].

Challenges of Digital Transformations in SSA

The impact of digital transformation is considerable, reshaping economies, societies, and industries worldwide. Digital technologies hold great potential for addressing long-standing development challenges and driving overall economic growth in SSA. There are significant challenges posed by regulations hindering digital transformations. Complex and outdated rules, bureaucratic hurdles, and inconsistent legal implementation create doubt for businesses and investors[12]. Regulatory barriers impede the advancement of the digital economy by obstructing innovation, entrepreneurship, and foreign direct investment. The lack of adequate infrastructure limits the utilization of technologies, restraining their impact on socio-economic development

There is uneven spread of access to digital technologies in SSA is not evenly spread out, making educational disparities even worse. Rural areas, less affluent families, and disadvantaged communities encounter obstacles in getting digital devices, internet access, and digital educational materials. There is also a notable gender gap in the availability of digital technologies, as girls and women are less likely than boys and men to have access to digital devices and internet

[10] World Bank. (2019). Facing Forward: Schooling for Learning in Africa. Washington, DC: World Bank.
[11] African Union Commission. (2018). Continental Education Strategy for Africa 2016-2025: Towards the Africa We Want. Addis Ababa, Ethiopia.
[12] UNCTAD (2023). UNCTAD'S Ecommerce and Digital Economy (ECDE) Programme. https://ecomafrica.org/blog/2023/05/10/unctads-ecommerce-and-digital-economy-ecde-programme/

connectivity.

The wide digital literacy and skills gaps remain a major problem to the transformation agenda. Digital transformation in education faces major obstacles due to insufficient digital literacy and skills among educators, students, and policymakers. Numerous educators do not have the required expertise and training to efficiently incorporate digital technologies into educational practices. Students may not have the necessary digital literacy skills to navigate online learning platforms and make use of digital resources efficiently. Targeted capacity-building initiatives and development programs for educators and students are needed to address digital literacy gaps.

There are large financial constraints limiting the expansion of digital technology in the region. Financial limitations create major obstacles for the implementation of digital transformation in education in SSA. Inadequate funding, conflicting priorities, and financial limitations restrict investments in digital infrastructure, teacher education, and digital learning materials in education. Moreover, the steep prices of digital gadgets, internet access, and software permits can be too expensive for numerous schools, students, and households, especially in impoverished areas.

Another big challenge is the substantial absence of infrastructure in terms of reliable electricity and internet connectivity. There are large infrastructure deficits such as electricity supply, internet connections, and ICT facilities, which are not as developed as in other regions. Records show that only 28% of people in SSA had access to electricity and internet usage. Disparities in access to digital technologies are exacerbated by variations in urban-rural locations, gender, and socio-economic status. Rural communities often lack necessary digital infrastructure and face challenges including cost, digital skills, and language diversity[13]. Table 1 shows the technological adoption rates in some countries. In 2020, the World Bank reported that just 22% of people in SSA had electricity, with internet usage levels differing greatly throughout the area. Insufficient infrastructure hinders the implementation and usage of digital technologies in education.

[13] World Bank Open Data. (2022). " World Bank. https://data.worldbank.org/ Accessed January 2024.

Table 1: Technological Adoption Rates in SSA

Country	Adoption Rate	Breakdown
Kenya	Moderate (50%)	Increased use of mobile phones for educational apps. Limited computer and tablet availability in some schools in rural areas. Growing internet connectivity in schools through initiatives.
Nigeria	Low to Moderate (30-40%)	Uneven distribution, e.g. urban schools have better access to technology. Limited teacher training for technology integration. Government initiatives to increase computer labs and internet access.
South Africa	Moderate to High (60-70%)	Relatively well-developed infrastructure in urban schools. Use of computers, tablets, and interactive boards in some classrooms. Challenges with digital literacy and teacher training in rural areas.
Rwanda	Moderate (45-50%)	Strong government push for one laptop per child program. Increased internet connectivity in schools, especially urban areas. Need for ongoing maintenance and software updates for technology.
Ghana	Low to Moderate (30-40%)	Growing use of mobile phones for educational purposes. Limited access to computers and tablets in many schools. Focus on integrating ICT into teacher training programs.

Note: The Table shows the technological adoption illustrating the rates (Column 2) at which digital technology is adopted for educational purposes in the selected SSA countries.

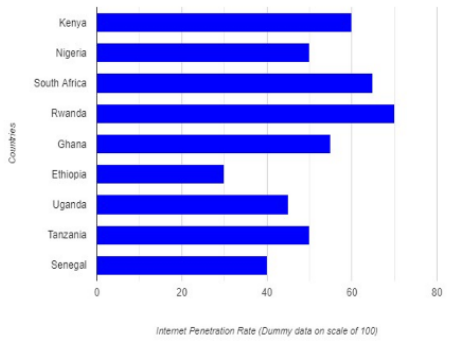

Figure 1: Internet Penetration Rate in SSA
Source: World Bank (2022)

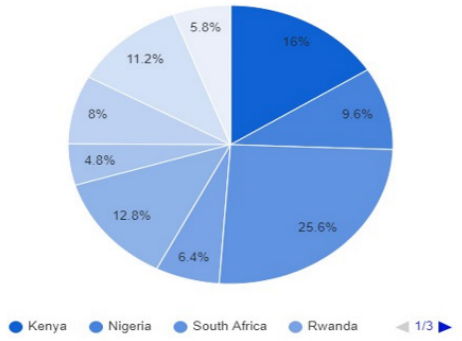

Figure 2: SSA Digital Transformation Budget (2020)
Source: African Development Bank (2020)

One major issue affecting digital transformations in the area is the existence of skill gaps and deficiencies in digital literacy. Despite the growing demand for digital skills in the workforce, educational systems in SSA often fail to equip students with the required abilities to thrive in the digital age. Obstacles to developing a digitally literate workforce include difficulties in delivering quality education, outdated curricula, and a shortage of trained teachers[14]. The digital progress in SSA faces a significant danger from cyber security threats. As digital technologies become more integrated into society, the region is increasingly exposed to the dangers of cyber-attacks, data breaches, and online fraud. Lack of adequate cyber security measures, ineffective regulations, and limited public awareness heighten the risks, endangering privacy, economic stability, and national security[15].

Digital transformations in SSA have the potential to drive sustainable development and inclusive growth. However, a range of complex issues including insufficient infrastructure, disparities in digital access, regulatory barriers, lack of skills, and cybersecurity threats are impeding the realization of this potential. Addressing these issues requires cooperation from governments, civil society,

[14] Organization for Economic Co-operation and Development (OECD). (2020). OECD Digital Economy Outlook 2020. Paris, France: OECD Publishing.

[15] Uba, J. (2021). The Legislative Framework for Cybercrime in Nigeria: Current Status, Issues and Recommendations.https://www.mondaq.com/nigeria/terrorism-homeland-security--defence/1136732/the-legislative-framework-for-cybercrime-in-nigeria-current-status-issues-and-recommendations

private sector stakeholders, and international partners to create a conducive environment for digital innovation and entrepreneurship in the region.

The Digital transformation is driving economic growth, societal inclusivity, and sustainable development worldwide. In SSA, digital technologies have great potential to surpass traditional obstacles and tackle long-standing issues. The region's path to digital transformation is characterized by a intricate mix of chances and challenges. In the last few years, SSA has seen a digital revolution that offers potential to change economies, societies, and governance in the area. Due to the rising internet usage, the spread of mobile devices, and increased digital infrastructure investments, SSA is set to utilize technology for inclusive growth and sustainable development.

SSA is bypassing traditional development routes by adopting digital technologies to address enduring obstacles. Mobile money services like M-Pesa in Kenya have transformed financial inclusion, allowing millions to utilize formal banking and conduct transactions via their mobile devices[16]. Likewise, online shopping platforms such as Jumia are revolutionizing the retail industry in Nigeria by granting customers easy access to a diverse selection of goods and services (McKinsey, 2020). Governments in SSA are now more aware of the significance of digital transformation in promoting economic growth, enhancing service delivery, and encouraging innovation. Numerous nations have introduced national plans, strategies, and policies with the goal of enhancing digital skills, improving broadband infrastructure, and fostering a supportive environment for digital business (ITU, 2021).

An illustration is Rwanda's Vision 2050, which strives to establish the nation as a digital center for Africa, through investing in ICT infrastructure, enhancing digital skills, and fostering innovation ecosystems. The private sector is crucial in spearheading digital changes in SSA by investing in telecommunications, e-commerce, and digital services. Mobile network providers like MTN and Airtel are growing their networks and introducing new products and services to keep up with changing consumer demands[17]. At the same time, technology startups are utilizing digital tools to tackle specific issues within sectors like healthcare, agriculture, education, and energy.

[16] Consultative Group to Assist the Poor (CGAP). (2021). Digital Finance in Sub-Saharan Africa: A Business and Investment Landscape. Washington, DC: CGAP.

[17] GSMA. (2021). Mobile Economy Sub-Saharan Africa 2021. London, UK: GSMA Intelligence.

Although there have been advancements in increasing internet access and mobile usage in SSA, there are still existing digital divides that affect rural areas, women, youth, and people with disabilities in terms of accessing and using digital technologies. To bridge these gaps, we need specific measures to encourage digital skills, accessibility, and inclusiveness (UNESCO, 2021). Efforts like the Alliance for Affordable Internet (A4AI) aim to lower internet access costs and advocate for policies to ensure everyone can afford broadband (A4AI, 2021).

Frameworks of Digital Transformation in Education

The use of technology and shifts in educational beliefs are leading to changes in teaching and learning methods globally, shaping education through digital transformation. Multiple worldwide patterns and structures have surfaced to lead and educate the incorporation of digital technologies in educational systems, enabling better and fairer learning experiences for students. This article examines a few of these patterns and structures, emphasizing their importance in influencing the future of education.

(a) *Personalized Learning and Adaptive Technologies:* Customized instruction, made possible by adaptive technologies and data analytics, is a key trend in the digital revolution of education. Adaptive learning platforms customize teaching and materials to accommodate the unique requirements, choices, and speed of every student, enhancing participation and success[18]. Through the utilization of information from student data, teachers can offer specific assistance and actions to enhance educational achievements.

(b) *Blended Learning and Hybrid Models:* In educational settings across the globe, blended learning - which blends traditional in-person instruction with online learning modalities - is becoming more and more common. Students can access instructional resources and content both within and outside of the classroom with blended learning's flexibility and customization. With their synchronous and asynchronous components, hybrid learning methods of education offer chances for group projects, independent study, and immediate feedback.

[18] Educause. (2020). 7 Things You Should Know About Adaptive Learning. Retrieved from https://library.educause.edu/resources/2020/9/7-things-you-should-know-about-adaptive-learning.

(c) *Digital Citizenship and Media Literacy:* Promoting media literacy and digital citizenship in the digital age is crucial to equipping students to responsibly browse and assess digital material. Frameworks for digital citizenship place a strong emphasis on the value of moral conduct, internet safety, privacy protection, and responsible use of digital resources and tools. By teaching students how to assess, create, and analyse media on a variety of platforms, media literacy education promotes critical thinking and digital literacy[19].

(d) *Open Educational Resources and Open Pedagogy:* More accessibility, affordability, and diversity in education are being fueled by the open education movement, which is defined using open educational resources (OER) and open pedagogical approaches (Wiley & Hilton, 2018). OER lowers barriers to access and facilitates collaborative knowledge creation by making textbooks, courses, and multimedia resources freely available for usage, adaptation, and sharing (UNESCO, 2019). By encouraging teachers and students to collaborate in the creation of information, open pedagogy promotes critical thinking, creativity, and self-reliance.

(e) *Data-driven Decision Making and Learning Analytics:* Learning analytics and data-driven decision making are influencing educational research, practice, and policy more and more by providing insights into the behaviour, engagement, and performance of students. According to Siemens and Gasevic (2012), learning analytics uses data from digital learning environments to track student progress, spot learning gaps, and guide instructional tactics. By utilising data analytics, educators may make well-informed decisions that maximise learning opportunities and foster student achievement[20].

Importance of Digital Transformation in Education

The use of digital technology for education provides various advantages and potential for students, teachers, and schools. The importance of digital

[19] Hobbs, R. (2018). Discovering media literacy: Teaching digital media and popular culture in elementary school. Thousand Oaks, CA: Corwin.

[20] Siemens, G., & Gasevic, D. (2012). Learning analytics: envisioning a research discipline and a domain of practice. In Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (pp. 1-9).

transformation in education includes improving access, fairness, quality, involvement, innovation, and productivity.

(a) *Enhancing Access and Equity:* The possibility of digital transformation in education is that it can connect people from different locations and backgrounds by offering learning opportunities. Online learning platforms, open educational resources (OER), and digital libraries provide learners with the opportunity to access educational materials at any time and from any location, thus making knowledge and educational resources more accessible to all[21]. Digital education promotes fairness and inclusion in education by targeting underserved populations like rural communities, women, and individuals with disabilities[22].

(b) *Improving Quality and Relevance:* Digital technologies provide new and creative tools and resources that can improve the effectiveness and significance of education. According to Bates (2019), interactive multimedia content, simulations, virtual laboratories, and educational games offer engaging learning experiences that immerse and inspire students. Moreover, adaptive learning systems tailor instruction for each learner, allowing educators to effectively cater to a variety of learning preferences and skills.

(c) *Fostering Engagement and Collaboration: Digital* transformation encourages involvement, teamwork, and communication between students, teachers, and classmates. Online discussion forums, collaborative projects, and social media platforms help improve the learning experience by promoting communication, collaboration, and knowledge sharing (Dede, 2010). Online classrooms and video conferencing software allow both real-time and delayed communication, bridging gaps caused by distance and linking students worldwide.

(d) *Encouraging Innovation and Creativity:* Digital technologies give educators and students the ability to discover different teaching methods, techniques, and educational settings. Blended learning

[21] UNESCO. (2019). Open Educational Resources: Global Report 2017. Paris, France: UNESCO.

[22] UNESCO. (2020). Global Education Monitoring Report 2020: Inclusion and education: All means all. Paris, France: UNESCO.

methods, flipped classrooms, and project-based learning all promote creativity, critical thinking, and problem-solving abilities. Educators can utilize digital tools and platforms to develop and distribute educational materials, tests, and materials, promoting an environment of innovation and cooperation in the field of education.

(e) *Enhancing Efficiency and Scalability:* Digital transformation enhances efficiency and productivity by streamlining administrative processes, resource management, and communication in educational institutions. Educators can concentrate on teaching and learning thanks to the automation of daily tasks by learning management systems (LMS), student information systems (SIS), and digital assessment tools[23]. In addition, online education allows for the efficient distribution of educational materials and resources to a wide range of students, cutting expenses and enhancing availability.

(f) *Facilitating Lifelong Learning and Professional Development: Digital* transformation in education goes beyond traditional classrooms by offering opportunities for lifelong learning and professional development to learners of all ages. Online courses, webinars, and virtual workshops provide convenient and available options for people to gain new skills, stay updated, and strive for career growth. Digital badges, certificates, and micro credentials acknowledge and confirm learning accomplishments, aiding in the advancement of continuous learning and skill enhancement.

(g) *Preparing Learners for the Digital Age:* In a world that is becoming more and more digital, it is crucial to have digital literacy and fluency to succeed in education, work, and society. Digital transformation in education provides students with the necessary digital skills, competencies, and literacies to succeed in the digital era (UNESCO, 2019). By incorporating digital technologies in education, teachers help students develop skills such as critical thinking and digital citizenship, leading to a lifetime of learning. Advancing education in the 21st century requires digital transformation[24], which provides chances to improve access, equity,

[23] Bates, A. W. (2019). Teaching in a Digital Age: Guidelines for Designing Teaching and Learning (2nd ed.). Vancouver, BC: Tony Bates Associates Ltd.

[24] Zickafoose A, Ilesanmi O, Diaz-Manrique M, Adeyemi AE, Walumbe B, Strong R, Wingenbach

quality, engagement, innovation, efficiency, and lifelong learning. Education can adapt to the ever-changing needs and challenges of learners by utilizing the capabilities of digital technologies.

3. Digital Transformation and Learning Outcomes

Impact of Digital Transformation on Learning Outcomes

The educational landscape has been completely changed by the digital revolution, turning normal classrooms into exciting digital learning spaces. Despite the undeniable advantages of digital transformation on learning outcomes, its effects are still a complicated matter with both positive and negative results. Digital tools have the advantage of increasing participation and meeting the needs of various learning preferences. Engaging simulations, educational games, and multimedia content can enhance the learning experience, leading to a better grasp of concepts.

Nevertheless, the success of digital transformation relies on how it is executed. Just adding technology to classrooms does not ensure enhanced learning outcomes. Improper use of technology may lead to distraction and impede the development of critical thinking abilities. Moreover, the digital divide represents a major obstacle. Unequal availability of technology and consistent internet access can worsen current educational disparities.

Some impacts of digital transformation are discussed:

(a) *Improved Access and Equity:* Enhanced access to educational resources and opportunities is a major advantage of digital transformation in education, irrespective of where individuals are located or their socio-economic background. Digital platforms and online resources provide learners with the opportunity to reach educational materials at any time and place, creating a fair educational environment and advancing equality in education. Yet, it is crucial to assess the efficacy of digital projects in tackling inequalities and guaranteeing fair access for every student.

G, Rodriguez MT, Dooley K. Barriers and Challenges Affecting Quality Education (Sustainable Development Goal #4) in Sub-Saharan Africa by 2030. *Sustainability*. 2024; 16(7):2657. https://doi.org/10.3390/su16072657

(b) *Personalized Learning Experiences:* Digital technologies enable customized learning experiences designed for the unique requirements, choices, and speed of each learner. Educators can customize instruction, offer targeted interventions, and track student progress more effectively thanks to adaptive learning platforms, data analytics, and artificial intelligence algorithms. Assessing the effects of personalized learning on learning results involves evaluating not just academic performance but aspects like engagement, motivation, and self-belief.

(c) *Enhanced Engagement and Collaboration:* Digital transformation promotes participation and collaboration between students, teachers, and peers using interactive multimedia, online forums, and group projects. Utilizing digital technologies in educational settings can boost student motivation, engagement, and memory, resulting in better learning results[25]. Yet, assessing the efficacy of digital engagement tactics involves taking qualitative indicators of student involvement into account along with quantitative metrics.

(d) *Development of 21st-Century Skills:* The focus of digital transformation in education is on nurturing 21st-century abilities like critical thinking, collaboration, communication, and digital literacy. The skills necessary for success in the digital era are cultivated through project-based learning, problem-solving tasks, and collaborative projects supported by digital tools[26]. Assessing the effects of digital transformation on 21st-century skills involves evaluating not just gaining knowledge, but also applying and transferring skills in real-life situation.

(e) *Access to Diverse Learning Resources*: Digital technologies provide a wide range of educational materials such as online textbooks, multimedia content, virtual simulations, and open educational resources. These materials offer students the chance to explore current information, varied viewpoints, and engaging learning opportunities. Through increased availability of top-notch educational materials, digital innovation can enhance the educational setting and enable more in-depth examination of topics, resulting in improved learning results.

[25] OECD Digital Education Outlook (2023). *Towards an Effective Digital Education Ecosystem.* https://www.oecd-ilibrary.org/education/digital-education-strategies-2024_384f9853-en.

[26] UNCTAD (2023). UNCTAD'S Ecommerce and Digital Economy (ECDE) Programme. https://ecomafrica.org/blog/2023/05/10/unctads-ecommerce-and-digital-economy-ecde-programme/

4. Access, Equity, and Inclusion in Digital Education

The rapid growth of digital technologies in education has brought about a new era of learning opportunities. Nevertheless, the significant challenge persists in ensuring fair access and promoting genuine inclusion in this digital environment. Precisely assessing these elements is essential for assessing advancement and pinpointing areas in need of enhancement. Access is at the heart, the basic capability to engage in online learning. Conventional measures concentrate on hardware accessibility: the quantity of devices given to students, or schools with internet access. Although significant, these measures offer a constrained view. Aspects such as the speed of the internet, the cost of data, and the availability of electricity have a large influence on the quality of access[27].

Equity goes further than just having access, it investigates the fairness of the digital learning journey. Do all students have the required skills and resources to make effective use of technology? This entails evaluating digital literacy - the skill to navigate online platforms, analyze information critically, and use technology for educational purposes. The end goal of inclusion extends past just physical entry and technical abilities. It includes a feeling of fitting in and the capacity to engage effectively in online learning tasks. Factors such as representation in educational content, catering to various learning styles, and ensuring participation for students with disabilities are considered when measuring inclusion metrics. Evaluating student participation on digital platforms and their impact on the digital learning process can offer important information on inclusivity.

Multiple methods and techniques are available to assess these complex ideas. Surveys are able to gather students' and teachers' perceptions of technology access, abilities, and feelings of being included. Standardized exams can be modified to evaluate digital literacy abilities in addition to typical educational achievements. Examining data on website traffic and usage of online learning platforms can uncover trends in participation and pinpoint possible obstacles to inclusivity. Ensuring access, equity, and inclusion in digital education is essential for promoting quality education and addressing disparities in educational opportunities across SSA. Measurement of these factors requires comprehensive

[27] Roblyer, M. D., & Mishra, P. (2018). Measuring digital literacy for educators: A framework for integrating research and practice. Journal of Digital Learning in Teacher Education, 37(2), 104-121.

assessment frameworks that consider various dimensions of access, equity, and inclusion.

(a) *Access to Digital Technologies:* Evaluating access to digital technologies includes analyzing the accessibility and cost of infrastructure, devices, and internet connection. Important factors to consider are rates of internet usage, ownership of cell phones, availability of electricity, and access to digital educational material[28]. Methods such as household surveys, population censuses, and ICT infrastructure mapping are utilized to gather information on digital technology access in SSA[29].

(b) *Equity in Digital Education:* Equity in digital education means guaranteeing all students have the same chances to use and gain from digital learning resources and opportunities. Assessing equity entails looking at variations in access, participation, and educational achievements among various demographic groups like rural versus urban, low-income versus high-income, and male versus female[30]. Equity indicators might consist of gender equality in internet usage, economic status of digital students, and allocation of digital resources in various areas.

(c) *Inclusion of Marginalized Groups:* Ensuring access to digital education involves removing obstacles to engagement and learning for disadvantaged groups like girls, children with disabilities, and those living in rural areas. Assessment of inclusion involves evaluating how well digital education efforts are reaching and helping marginalized learners and meeting their requirements. Some indicators of inclusive education could involve the percentage of girls enrolled in Science, Technology, Engineering and Mathematics (STEM) courses, the presence of accessibility features on online learning platforms, and the accessibility of inclusive educational materials.

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[28] UNESCO. (2021). Global Education Monitoring Report 2021: The Hidden Crisis: Armed conflict and education. Paris, France: UNESCO.

[29] World Bank. (2021). Africa's Pulse, No. 23, October 2021: Analysis of Issues Shaping Africa's Economic Future. Washington, DC: World Bank.

[30] African Development Bank (AfDB), (2020). Investing in the youth is key to Africa's digital transformation and financial inclusion – African Development Bank East Africa Director Generalhttps://www.afdb.org/en/news-and-events/investing-youth-key-africas-digital transformation-and-financial-inclusion-african-development-bank-east-africa-director general-53918.

(d) *Policy and Program Evaluation:* Assessing digital education policies and programs is crucial to determine their success in advancing access, equity, and inclusion. Evaluation methods such as impact process evaluations, and cost-effectiveness analyses are employed to evaluate the results and effects of digital education initiatives. Assessing policies and programs gives information on the strengths, weaknesses, and areas for enhancement of digital education initiatives.

(e) *Stakeholder Engagement and Collaboration:* Collaboration and engagement with various stakeholders such as government agencies, NGOs, civil society organizations, and international partners are necessary to assess access, equity, and inclusion in digital education. Engaging with stakeholders, hosting workshops with participation, and organizing forums with multiple stakeholders help in fostering conversations, sharing knowledge, and reaching agreements on methods and actions for enhancing access, fairness, and diversity in digital education.

5. Conclusions

In a bid to achieve the digital transformation in SSA, the article suggests that:

1. Governments, international organizations, and private sector stakeholders need to work together to create and put into action thorough plans for building digital infrastructure.
2. Stakeholders should aim bridge the digital gap by granting digital technology access to marginalized populations like rural communities, and low-income households.
3. There should be increased efforts like offering discounted internet access, providing affordable digital devices, and establishing community-based ICT centers to encourage digital participation.
4. There is a need to create and adjust digital educational material that is suitable for the local culture, aligns with curriculum frameworks, and meets learning goals.
5. There should be collaboration among various partners such as governments, schools, partners in development, non-profit

organizations, and businesses to advance digital revolution in education.

6. Networks, groups, and teams that focus on sharing knowledge, collaborating, and coordinating can help with working together and mobilizing resources.

In conclusion, the complexities of digital transformation in education in SSA necessitate collaborative actions from different parties to be tackled successfully. In spite of the possible advantages of digital technologies in enhancing education's access, equity, and quality, the area encounters notable obstacles like lacking infrastructure, barriers to access and inclusion, gaps in digital literacy, financial limitations, policy difficulties, and regulatory barriers.

Nevertheless, there is cause for hope as potential solutions and suggestions have been put forward to address these difficulties. Through taking a comprehensive approach to infrastructure growth, ensuring fair access and inclusion, investing in skill development, localizing educational material, securing financial resources, implementing policy changes, and forming partnerships, SSA can surmount obstacles to digital education transformation.

It is crucial that governments, educational institutions, development partners, civil society organizations, and the private sector collaborate effectively to carry out these recommendations in a unified and long-lasting approach. By working together and being dedicated, SSA has the potential to utilize digital technologies to improve education, empower students, and create a better future for future generations.

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