Teaching and Learning in the Cloud: Prospects and Challenges of Artificial Intelligence for Education in Africa

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Abstract

Artificial Intelligence (AI) is gradually revolutionizing several sectors, including healthcare, education, energy, agriculture, finance and manufacturing, among others. No wonder AI is considered a tool for sustainable development[1]. Like other sectors, education—broadly defined to include not only the formal schooling process but also other forms of Teaching and Learning (T&L) coordinated by educational institutions, Intergovernmental Organizations, Non-Governmental Organizations (NGOs), businesses, government agencies and similar stakeholders, for instance specialized courses — is also benefiting from AI. These technologies offer a way to surmount constraints associated with traditional T&L and, invariably a means to improve access to, quality of and an overall experience with education, fostering Sustainable Development Goal 4. Against this backdrop, we ask a central question: what are the prospects and challenges of AI in Africa's education systems?

We use qualitative literature review and documentary analysis to answer the question. AI is new in Africa's education field, so we mostly rely on global studies. Nonetheless, Facebook, Google and other industry players are already exploring and supporting AI opportunities in the continent, including education-related aspects. Synthesizing the global studies on AI for education and reports on recent industry leadership on AI, we distill the prospects and challenges of AI for T&L in Africa.

We identify four learning and two teaching prospects, but there are potentially others. Starting with the learning prospects, AI allows smart learning. Students can have personalized instruction. Apart from allowing them to go at their own pace, there might be diverse learning options, some of which may also tackle learning disabilities. Also, AI could reinforce student learning by combining technology interface with face-to-face interaction as blended learning. Blended learning is richer for many reasons, for instance in allowing for diversity in learning pathways and reinforcing learning sessions. Additionally, AI provides a means to build a learning community. AI applications that allow participant interaction create a platform to build relationships that could enhance learning, for instance study groups across different educational systems. Further, AI will

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[1] UNESCO, "Artificial Intelligence in Education: Challenges and Opportunities"

potentially obliterate learning inequality. Although still relatively expensive, AI costs will eventually fall with industry competition, as we have seen with telecommunication, so students that might not be able to afford going to school will likely have alternative access. Turning to the teaching prospects, AI will give teachers flexibility. Depending on the specific technology, using AI could reduce the burden of attending classrooms, marking papers and other tasks, enhancing the overall teaching experience and quality. Again, like students, teachers could also build communities. Peers and mentors may emerge from such communities, invariably boosting teaching experience and quality.

Despite these benefits, there are also challenges. We group these challenges into three interwoven categories: policy, techno-economic and security. The first group is about the far-reaching policy change African countries would need to incorporate AI in T&L. Apart from the lack of expertise, there would also be financial and other practical difficulties. Flowing from the first category, the second category suggests that AI will give intellectual and financial advantage to some countries, communities and people over others, at least in the short-term[2]. Driven by technology and finance, the more educated and financially buoyant will have early and better access to AI. Then comes the third category on the potential of security breach. Technology always comes with security risks! As we move T&L farther into the cloud, we will be more exposed, and those with sophisticated AI expertise could gain access to our otherwise private life, among other potential problems.

Keywords: Artificial Intelligence (AI), Teaching and Learning (T&L), Education, Sustainable Development Goal 4, Africa

1. Introduction

Artificial Intelligence (AI) is gradually revolutionizing several sectors, including healthcare, education, energy, agriculture, finance and manufacturing, among others[3]. AI has impacted education, as a teaching and learning process for knowledge and skills acquisition by individuals and groups, with varying degrees of outcomes. Intelligent Tutoring Systems, Jill Watson (not human) at Georgia Institute of Technology, Duolingo, AutoTutor, Carnegie Mellon University's RoboTutor Intelligent System, Third Space Learning and others AI initiatives have shown significant promise for teaching and learning.

To ensure inclusive and equitable quality education whilst promoting lifelong learning opportunities in line with the Sustainable Development Goal 4, we must promote AI for educational activities in developing countries. We argue that AI offers benefits in increasing access to quality education in Africa. Thus, this article explores the following questions in detail: What are the AI initiatives for education in Africa? What are the prospects and challenges of AI in Africa's education systems? What is the future of AI for education in Africa? To answer these questions, we use qualitative literature review and documentary analysis. These methods are justified because AI is still at its infancy on the continent, hence why we rely on secondary sources.

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[2] Goralski and Tan, "Artificial Intelligence and Sustainable Development", 2.
[3] Travaly and Muvunyi, "The Future is Intelligent".

2. Artificial Intelligence Initiatives for Education in Africa

There is no universally acceptable definition of AI in the literature. However, a comprehensive definition of AI refers to computing systems that can engage in human-like processes such as learning, adapting, synthesizing, self-correction and use of data for complex processing tasks[4]. The underlying concept of AI presupposes the creation of intelligent machines capable of learning from their environment (via data collection and analysis) and replicating tasks hitherto attributed to humans. As such, AI offers a way to surmount constraints associated with traditional teaching and learning methods and invariably, improve access to quality. If so, Africa, a continent of about 1.2 billion people of which 226 million are youths with an average age of 19 years[5], needs to leverage AI to bridge its literacy gap and subsequently, achieve the Sustainable Development Goal 4.

Though major industry players such as Google, IBM and Facebook have established AI research centres in Africa with the aim of advancing the knowledge of AI on the continent, local initiatives like Deep Learning Indaba, the African Institute for Mathematical Science (AIMS), Data Science Africa, Women+ in Machine Learning and Data Science (WIMLDS) and others have been strengthening the knowledge of AI in Africa. For instance, the African Institute for Mathematical Scientists (AIMS) in Rwanda, in partnership with Facebook and Google, offers a one-year master's programme in AI which aims at equipping graduate students with basic research skills in AI to respond to the present and future needs of Africa. Similarly, Data Science Nigeria (DSN) is an initiative which aims at training one million AI talents in the next 10 years. In 2019, DSN published a learning resource aimed at upscaling the skills of primary school learners in data science and AI.

While these initiatives have contributed to the growth of the nascent AI industry in Africa and subsequently, set the pace for AI revolution in Africa, little success has been recorded in the application of AI for education in Africa compared to developed regions. Though local initiatives such as M-Shule, Daptio, Tuteria and others have enhanced teaching and learning activities of students in Sub-Saharan Africa to some extent through their mobile learning and tutoring platforms, massive investment in AI for education is required to enable Africa leverage AI for the education of its teeming population.

3. Prospects of Artificial Intelligence for Education in Africa

AI is currently progressing at an accelerated pace, and this already impacts on the profound nature of services within higher education in developed regions[6]. However, the adoption and use of AI for education in Africa is still at the early stages. Integrating AI capabilities into the education system brings greater benefits to teachers and students alike, allowing for a more personalized academic path, better results and better prepared individuals[7]. For this paper, we place emphasis on the teaching and learning prospects in the application of AI for education in Africa.

3.1. Learning prospects

AI allows smart learning as African students can have personalized learning instructions in their areas of interests. With the aid of AI, homework and classes could be customized based on student's aptitudes, needs and interests, while their overall performance in the assessments could be analyzed to determine relevant resources to help students understand the assigned tasks. AI

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[4] Popenici and Kerr, "Exploring the Impact of Artificial Intelligence," 2.
[5] Yahya, "Africa's Defining Challenge,"
[6] Popenici and Kerr, "Exploring the Impact of Artificial Intelligence," 2.
[7] Strongbytes, "AI Brings Smart Learning Experiences in Schools".

will play a vital role of a personalized learning resource allocator for students, thereby helping teachers focus more on facilitation, while technology handles the intricacies of teaching and learning assessment and resource distribution[8].

Apart from allowing students to learn at their own pace, there might be diverse learning options, some of which may also tackle learning disabilities. The use of AI such as Tutoring Software, robots and humanoids has shown benefits in enhancing the learning experience of students with Autistic Spectrum Disorder (ASD). Similarly, Immersive Reader is an AI service which enhances reading and comprehension through text decoding solutions for students with learning differences such as dyslexia[9].

AI could also reinforce student learning by combining technology interface with face-to-face interaction as blended learning. Before the advent of AI and other modern instructional technologies, learning in educational institutions was predominantly based on physical interaction between instructors and students. Though this traditional model was effective in educating limited number of students at a given time, constraints such as geographical barriers, limited space and time difference must be resolved to get the best experience out of such learning exercise. Application of AI tools could remove barriers associated with conventional learning methods and recreate unique classroom experience for reinforced learning activities. Blended learning is richer for many reasons, for instance in allowing for diversity in learning pathways and reinforcing learning sessions. Blended learning combines the online delivery of educational content with the best features of classroom interaction and live instruction in such a way as to personalize learning, allow thoughtful reflection, and differentiate instruction from student to student across a diverse group of learners[10].

Additionally, AI provides a means to build a [11]learning community. AI applications that allow participant interaction create a platform to build relationships that could enhance learning, for instance study groups across different educational systems. With the aid of AI, participants in educational programmes could engage in group discussions, share resources and collaborate on ideas to advance their knowledge on different topics. AI support online collaborative learning discussions among students by using academically productive talk moves. AI applications could also assist African students to monitor conversations in many groups using recording devices and link them with more experienced colleagues, thus fostering peer mentoring within the learning community.

Further, AI will potentially obliterate learning inequality in Africa. It provides marginalized people and communities, people with disabilities, refugees, those out of school, and those living in isolated communities with access to appropriate learning opportunities[12]. With the advancement in AI, African students can have access to personalized instruction in real-time with adequate feedback (synchronous learning) and as self-paced interaction with flexible schedules (asynchronous learning). AI could also advance quality education with highly personalized teaching programs for all ages across the world[13]. Although still relatively expensive, AI costs will

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[8] Jude, "Artificial Intelligence as an Assessment tool for Education in Africa".

[9] Schools ICT "What is Immersive Reader?"

[10] Watson, "Blended Learning".

[11] Adamson, David et al., "Towards an agile approach to adapting support to student needs," 93.

[12] UNESCO, "Artificial Intelligence in Education: Challenges and Opportunities".

[13] IDRC, "Building a Network of Excellence in Artificial Intelligence in Sub-Saharan Africa".

eventually fall with industry competition, as we have seen with telecommunication. Students that might not be able to afford going to school in Africa will likely have alternative access.

3.2.   *Teaching prospects*

AI will give flexibility to teachers in African educational institutions. Depending on the specific technology, using AI could reduce the burden of attending classrooms, marking papers and other tasks, enhancing the overall teaching experience and quality. The use of AI could assist teachers in identifying the learning needs and abilities of individual students and developing appropriate measures to respond to such needs.

Also, teacher-facing AI systems are used to support the teacher and reduce workload by automating tasks such as administration, assessment, feedback, and plagiarism detection[14]. AI could also provide additional support for teachers in analyzing students' data, predicting their academic achievements and proffering solutions to address their learning challenges.

Importantly, AI helps educators have greater insight as to how students are progressing. That means they could adjust their approach, supporting students' individual needs[15]. Furthermore, the use of AI could provide African teachers with adequate information on unique attributes of individual students which could influence their career paths.

Again, African teachers could also leverage AI capabilities to build learning communities with their colleagues. Furthermore, AI could foster the development of smart content and platforms for professional development of teachers. Peers and mentors may emerge from such communities, invariably boosting teaching experience and quality including AI mentors for learners, further development of for educators through virtual global conferences.

4. Challenges of Artificial Intelligence for Education in Africa

Despite the enormous benefits of AI in education, there are some challenges bedeviling the application of AI for education in Africa. We conceptualize these challenges into three interwoven categories: policy, techno-economic and security. These categories are not intended to be exhaustive, but we consider them to be significant.

4.1.   Policy

There is far-reaching policy change which African countries would need to address to successfully incorporate AI in teaching and learning. A comprehensive policy framework, much of which would require overhaul of current policies and creation of new ones, is a prerequisite for fostering participation by industry players and for achieving a sustainable environment where the application of AI of education will thrive. Besaw and Filitiz suggest that delivering the promise of positive AI will require good systems of governance, which constitute part of the policy framework[16].

In expressing the need for appropriate AI policies for education, Ayoub expresses that educators see AI as instrumental to their institution's competitiveness, yet most institutions still lack a formal

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[14] Zawacki-Richter et al., "Systematic Review of Research on Artificial Intelligence," 4.

[15] Risugu, "Africa: AI Could Be the Boost Education in Africa Needs".

[16] Besaw and Filitiz, "Artificial Intelligence in Africa is a Double-edged Sword"

data strategy to advance AI[17]. Even though, most African countries have ICT policies that are being implemented effectively, there is still a dearth of AI policies in Africa.

Overall, compared to Europe, Canada, the U.S., and China, there is no well-documented strategy for AI in Africa[18]. While we can learn from other regions, we cannot import policies that may not fit the context of African societies. Thus, relevant policies which will create clear directions on the application of AI for education in line with the peculiarities of the African continent need to be developed.

4.2. Techno-economic

The optimization of AI for education requires an environment with adequate infrastructure, state-of-the-art data facilities and requisite AI expertise, which are largely inadequate in Africa. Extremely inconsistent IT infrastructure represents a major challenge that needs to be addressed by various African governments and the private sector, mostly because AI requires robust networks, immense computing power, and stable connections[19].

The absence of sufficient technical infrastructures, AI skills and data gaps as well as poor regulatory environments for these limits the application of AI for education in Africa. This often results in intellectual and financial advantage to some countries, communities and people over others[20], at least in the short-term. Driven by technology and finance, the more educated and financially buoyant will have early and better access to AI.

4.3. Security and related data Issues

While AI offers enormous benefits to teaching and learning, its proper functioning relies on the collection and analysis of personal data of students and faculty members in educational programmes. The collection of such confidential information raises serious issues of privacy and data protection[21]. Safety and security issues regarding AI-based systems revolve around concepts such as safe AI for use by humans, verification, validation, self-awareness in adversary-prone environments[22].

As AI systems becomes more integrated into teaching and learning, participants of educational programmes will be more exposed to unintended risks as other people could gain unauthorized access to their otherwise private lives, among other potential problems. Furthermore, since AI relies on data, its outcome and subsequent use are as good as the data put into it. Where the given data provides for a chance of having a misleading outcome, there is a high chance that AI could bring about serious problems to that effect[23].

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[17] Ayoub, "Unleashing the power of AI for education".
[18] Nayebare, "Artificial Intelligence Policies in Africa Over the Next Five Years" 52.
[19] Buttice, "The Future of Artificial Intelligence in Africa: Risks and Opportunities"
[20] Goralski and Tan, "Artificial Intelligence and Sustainable Development", 2.

[21] Zawacki-Richter et al., "Systematic Review of Research on Artificial Intelligence," 2.
[22] Fagbola and Thakur, "Towards the Development of AI-based Systems".
[23] Michalski, R.S., Carbonell, J.G. & Mitchell, T.M. (2013) Machine Learning: An Artificial Intelligence Approach. Springer Science & Business Media, Berlin.

5. Conclusion

AI unarguably holds the potential to revolutionize teaching and learning in Africa by eradicating challenges associated with conventional educational methods. The application of AI in teaching and learning has come to stay, and Africa will likely leverage AI to achieve its educational goals, including enhanced knowledge acquisition in the classroom settings and at home.

However, AI successes have been observed with some perceived risks, disruptive tendencies, and negative impacts[24]. These risks could undermine the benefits of AI for education in Africa and threatened the development of the Africa nascent AI industry, if not monitored properly. Currently, there are local initiatives which could transform the AI landscape in Africa through the development of exciting talents and world-class AI solutions capable of meeting the needs of the continent in the nearest future. A robust collaboration among AI startups, researchers, policy makers, industry players, educational institutions and government agencies is required to realize the full benefits of AI for education in Africa.

Invariably, AI has the capability to enrich teaching and learning experience in Africa, thus fostering the achievement of the Sustainable Development Goal 4. AI, like every other technology, is a tool which effectiveness hinges on the way it is used, and the type of data inputted into it. Before Africa can lead its AI transformation, the region needs to formulate a comprehensive continental blueprint to guide its AI strategy by involving key Pan-African institutions, academia, and the private and public sectors in its conception[25]. Strict compliance to ethical use of AI for teaching and learning activities is also expedient. Furthermore, transparency and integrity in the use of personal data for AI systems must be ensured. Finally, relevant policies should be formulated to curtail excesses arising from the use of AI for education in Africa.

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[24] Berendt, "AI for the Common Good?"44.
[25] Travaly and Muvunyi, "The Future is Intelligent".

BIBLIOGRAPHY

Adamson, David., Dyke Gregory, Jang Hyeju, and Rosé Carolyn Penstein. "Towards an agile approach to adapting dynamic collaboration support to student needs." *International Journal of Artificial Intelligence in Education* 24, no. 1 (2014); 92–124. https://doi.org/10.1007/s40593-013-0012-6

Ayoub, Dan. "Unleashing the power of AI for education". *MIT Technology Review*. https://www.technologyreview.com/2020/03/04/905535/unleashing-the-power-of-ai-for-education/

Berendt, Bettina. "AI for the Common Good?! Pitfalls, challenges, and ethics pen-testing". *Paladyn, Journal of Behavioral Robotics* 10, no. 1 (2019), 44–65. https://doi.org/10.1515/pjbr-2019-0004

Besaw, Clayton, and Filitiz John. "Artificial Intelligence in Africa is a Double-edged Sword." Our World United Nations University. https://ourworld.unu.edu/en/ai-in-africa-is-a-double-edged-sword

Buttice, Claudio. "The Future of Artificial Intelligence in Africa: Risks and Opportunities" *The Elephant,* April 18 (2019). https://www.theelephant.info/ideas/2019/04/18/the-future-of-artificial-intelligence-in-africa-risks-and-opportunities/

Fagbola, Temidayo, and Thakur Surendra. "Towards the Development of Artificial Intelligence-based Systems: Human-Centered Functional Requirements and Open Problems". Paper presented at the *ICIIBMS 2019, Track 2: Artificial Intelligent, Robotics, and Human-Computer Interaction*, Shanghai, China, Nov.21-24-2019.

Goralski, Margaret and Tan, Keong. "Artificial Intelligence and Sustainable Development". *The International Journal of Management Education*, 18, no. 1 (2020): 1-9. https://doi.org/10.1016/j.ijme.2019.100330

International Development Research Centre. "Building a Network of Excellence in Artificial Intelligence in Sub-Saharan Africa". IDRC 2020 https://www.idrc.ca/en/project/building-network-excellence-artificial-intelligence-sub-saharan-africa

Jude, Ashiedu. "Artificial Intelligence as an Assessment tool for Education in Africa". *Educators Wealth Strategy,* January 22, 2018, https://www.ashiedujude.com.ng/2018/01/artificial-intelligence-as-assessment.html

Michalski, Ryszard, Carbonell Jamie, and Mitchell Tom. *Machine Learning: An Artificial Intelligence Approach*. Berlin: Springer Science & Business Media, 2013.

Nayebare, Michael. "Artificial Intelligence Policies in Africa Over the Next Five Years". *XRDS Winter* 26, no. 2 (2019): 50-54.

Popenici, Stefan and Kerr, Sharon. "Exploring the Impact of Artificial Intelligence on Teaching and Learning in Higher Education". *Research and Practice in Technology Enhanced Learning* 12, no. 22 (2017); 1-13. https://doi.org/10.1186/s41039-017-0062-8

Risugu, Michael. "Africa: AI Could Be the Boost Education in Africa Needs". *All Africa*, December 2, 2019. https://allafrica.com/stories/201912021010.html

Schools ICT, "What is Immersive Reader?" Accessed 26 June, 2020. https://schoolsict.co.uk/what-we-   do/office-365/learning-tools/immersive-reader

Strongbytes. "AI Brings Smart Learning Experiences in Schools". Last modified June 14, 2019. https://strongbytes.ai/smart-learning-experiences-are-the-future/

Travaly, Youssef and Muvunyi, Kevin. "The Future is Intelligent: Harnessing the Potential of Artificial Intelligence in Africa". *Africa in Focus*, January 13, 2020. https://www.brookings.edu/blog/africa-in-focus/2020/01/13/the-future-is-intelligent-harnessing-the-potential-of-artificial-intelligence-in-africa/

United Nations Educational, Scientific and Cultural Organization. "Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development". *UNESCO 2019 Working Papers on Educational Policy 07.*

Watson, John. "Blended Learning: The Convergence of Online and Face-to-Face Education". Promising Practices in Online Learning. North American Council for Online Learning, 2008, https://files.eric.ed.gov/fulltext/ED509636.pdf

Yahya, Mohammed, "Africa's defining challenge". *UNDP Africa,* August 7, (2017). https://www.africa.undp.org/content/rba/en/home/blog/2017/8/7/africa_defining_challenge.html

Zawacki-Richter, Olaf., Marin Victoria, Bond Melissa, and Gouverneur Franziska. "Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where are the Educators?" *International Journal of Educational Technology in Higher Education* 16, no. 39 (2019); 1-27. https://doi.org/10.1186/s41239-019-0171-0