

Emerging Assumptions and the Future of Artificial Intelligence in Teaching and Learning Processes in Higher Learning Institutions in Sub-Saharan Africa: A Review of Literature

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ABSTRACT

This paper explores emerging assumptions and the future of artificial intelligence in teaching and learning processes in Higher Learning Institutions in Sub-Saharan Africa. The paper assesses the use of interactive and engaging applications of artificial intelligence and emerging technologies in educational inferences and predicts its future in Higher Learning Institutions in Sub-Saharan Africa. The results were analysed, evaluated, compared, contrasted, and discussed in tandem with the Resource Based View Theory. The results show that the applications of artificial intelligence in teaching and learning processes bring together the world in which facilitators and students' network and share knowledge, skills, and experiences. But the technologies have threatened employment opportunities. The study recommends that artificial intelligence technologies should align with the environments, cultures, needs, and socio-economic developments of Sub-Saharan Africa. Also, higher learning institutions should endeavour to establish frameworks for infrastructure development and capacity building for the stakeholders.

Keywords: Artificial Intelligence, Higher Learning Institutions, Teaching and Learning processes, Sub-Saharan Africa, Education

1. INTRODUCTION

Artificial Intelligence (AI) technology is an interactive digital system such as robotics, computing, and the Internet of Things (IoT) which is autonomously programmed or controlled to replace humans in performing different activities (Vijayakumar & Sheshadri, 2019; Zheng, 2019; Han & Conti, 2020). In Teaching and Learning (T/L) processes, AI technology is a digitally programmed system autonomously or controlled to replace humans in engaged teachers and students' T/L processes (Popenici & Kerry, 2017; Matto, 2022). AI technology was designed in the field of electrical, mechanical, and computer science in 1920 as part of the Fourth Industrial Revolution (4IR) world

over. Later, it was adopted in the field of education to replace humans in T/L processes. Higher Learning Institutions (HLIs) in Sub-Saharan Africa (SSA) are not left behind in the wave of 4IR and AI technology in particular. Though, there are potential perils in the adoption of AI technology in T/L processes such as uneven adoption of AI technology in T/L processes (Butcher, Wilson-Strydom, Baijnath, Orlic, Smith, Neupane & Shawe-Taylor, 2021). The majority of populations are unprivileged, minimally utilize, and do not understand the effects and the future of AI technologies (Miailhe, 2018; Ocaña-Fernández, Valenzuela-Fernández & Garro-Aburto, 2019). Besides, amongst the top ten list of countries that benefit from AI technology, there is no SSA country (Butcher, *et al.*, 2021). The fact that there are challenges to adopting AI technology in T/L processes such as unstable power and Internet, expertise in production, and automation that do not align with the environments and cultures of SSA. There is an increase of studies on assumptions, opportunities, challenges, and the future of the use of interactive and engaging applications of AI in the T/L processes in HLIs the world over (Popenici and Kerry, 2017). In addition, the literature does not provide evidence of the application of AI technology in T/L processes in HLIs. Therefore, this study explores assumptions, opportunities, challenges, and the future of the use of AI technology in the T/L processes of HLIs in SSA. In light of this, the study at hand aims to analyse and synthesize findings across literature on the themes underpinning the study.

HLIs are inextricably entwined with the development of AI technology due to the observed importance of technology in the practices to engage teachers and students in T/L processes. Extant literature shows that AI technology predicts a brighter future of educational interventions at all levels in T/L endeavours (Streveler & Menekse, 2017). AI technology is used in the T/L processes as learning assistants, instructional materials, and T/L companions to engage students in acquiring knowledge, skills, and experiences (Kory & Breazeal, 2014). AI technology can be used by instructors and peer learners and they are effective in cognitive and affective domain outcomes on restricted T/L processes (Belpaeme, Kennedy, Ramachandran, Scassellati & Tanaka, 2018). In Australia, AI technology is used in advising students on academic issues conveniently at any time. This predicts the future quality of services, the question of time, and human resource needs assessment in HLIs (Popenici & Kerry, 2017). In particular, AI technology is interactive for the students to be reinforced for lifelong learning.

2. THEORETICAL FRAMEWORK

Several theoretical models have commonly been used to explain studies related to the emerging assumptions, opportunities, and challenges of the use of interactive and engaging applications of AI technology in the T/L processes in Sub-Saharan Africa. This study uses the Resource Based View (RBV) theory proposed by Barney in 1991 which describes the importance and competitive advantages that HLIs can attain by employing AI technology in T/L processes. The RBV theory essentially argues that the competitive advantage of an organization stems from a set of tangible and intangible resources at its disposal (Skilton, 2009). Materials in the RBV theory include assets, organizational processes, firm attributes, information, or knowledge controlled by the firm which can be used to conceive and implement their strategies. Examples of resources are brand names, technological abilities, and efficient procedures. As per RBV, ownership, and control of strategic assets determine an organization's ability to

earn superior profits and enjoy a position of competitive advantage over others (Skilton, 2009). Based on the existing literature, this study theorizes that HLIs as organizations can own, control and use AI resources for T/L processes and discharge their core functions effectively and thus generate competitive advantages. Therefore, to reap the benefits of any potential changes, HLIs in SSA need to consider T/L processes in light of RBV theory, AI, and other emerging technologies.

3. METHODOLOGY

This study surveyed and examined empirical literature as a review method on the emerging assumptions, opportunities, challenges, and the future of the use of interactive and engaging applications of AI technology in T/L processes in SSA. A detailed desk review of available literature on AI technology in T/L processes was surveyed for analysis. The surveyed literature included; books, journals, theses, electronic databases (ResearchGate, Google Scholar, BASE, CORE, and ERIC), and reports. The study went through two stages to obtain the surveyed literature. The first was the general literature search to identify literature potentially relevant as far as the focus of the study was concerned. The literature search employed various terms such as "emerging technologies", "artificial intelligence" "teaching and learning" AND "Sub-Saharan Africa". The second stage was the selection of specific thematic literature out of the broad literature. A total of 25 pieces of literature were found to be appropriate as they were found to be in line with the focus of this study and thus reviewed. The literature reviewed was analysed in light of the qualitative data content analysis approach and their main points were summarized to meet the study objectives.

4. RESULTS AND DISCUSSIONS

4.1 Assumptions of the Application of AI Technology in T/L Processes

The advanced technology in this era calls for dynamic assumptions on the application of emerging technologies in service provision and sharing information resources (Butcher et al., 2021). The emerging technologies to date include; the Internet of Things (IoT), Big data, Blockchain technologies, Cloud computing, 3D printing and Artificial Intelligence (AI) (Mwilongo & Kotoroi, 2021). These technologies are crucial in modernising human activities. For instance, AI technology is presumed to assist functions in industries, health sectors, politics, economy, agricultural, and education activities (Luan et al., 2020; Onaolapo & Onifade, 2020). AI technology in SSA is ranked in the global Government AI Readiness Index of 2020 where five African countries were featured in. These countries were Mauritius which ranked 45th in the world, followed by South Africa the 59th, Seychelles - 68th, Kenya - the 71st, and Rwanda - 87th (Gwagwa *et al.*, 2021). The HLIs of these countries adopted and kept on using AI technology in T/L processes.

The AI technology supports trainees with intelligent tutoring platforms and automated instruction facilities. Intelligent tutoring technology has the potential in offering individual trainee assignments by tailoring learning resources to a particular trainee's needs and generally assisting them to work at their own pace (Butcher *et al.*, 2021). The advanced development in information technology has led to a big data explosion that has brought complexity to knowledge organisations based on the subject matter and needs of users. In this regard, and with an automated workforce, the information is easily aggregated by the AI sensor technologies to subject-based databases for easy

retrieval of information in the process of teaching and learning (Luan et al., 2020; Butcher *et al.*, 2021).

The initiatives and operational assumptions on the AI technology application in HLIs have impacted the teaching and learning process among academic communities and researchers (Gwagwa et al., 2021). For instance, the application of Intelligent Tutoring Systems, Jill Watson platform, Duolingo, AutoTutor, RoboTutor Intelligent System, and Third Space Learning have been popular AI technologies for T/L processes of the HLIs of the United States of America (USA) (Onaolapo & Onifade, 2020; Gwagwa *et al.*, 2021). In this, the HLIs of Sub-Saharan Africa have fairly invested in AI technology with varying platforms; The University of Pretoria (UP) in South Africa established the Intelligent Systems Group (ISG) to intelligently support T/L processes and other educational administrative functions (Butcher *et al.*, 2021). HLIs of Kenya, Rwanda, and some few Sub-Sahara African countries interchangeably have kept on using M-Shule, Dpatio, Tuteria, AutoTutor, and Tutoring Systems in fostering T/L processes (Luan *et al.*, 2020; Onaolapo & Onifade, 2020).

Furthermore, there are initiatives toward supporting universities in SSA to apply AI technology in T/L processes (Vemon, 2019). For instance, the major industry platforms including Google, the International Business Machines Corporation (IBM), and Facebook have developed AI research centres in Africa to support efforts on AI technology (Onaolapo & Onifade, 2020). Google and Facebook supported the African Institute of Mathematical Sciences (AIMS) initiatives in AI technology projects for T/L in Kigali, Rwanda, in 2018. In the same year, Google facilitated the establishment of an AI research laboratory in Accra, Ghana (Onaolapo & Onifade, 2020). On the other hand, local initiatives among the SSA HLIs on AI technologies for T/L processes have been earmarked in various regions. For instance, South Africa's Centre for Artificial Intelligence Research (CAIR) has developed a program for AI expertise capacity building since 2011. The centre incorporates nine research institutions from six universities. These universities are; the University of Cape Town, the University of KwaZulu-Natal, North-West University, the University of Pretoria, Stellenbosch University, and the University of the Western Cape (Gwagwa *et al.*, 2021).

In Ethiopia, the Addis Ababa Science and Technology University developed the AI and Robotics Centre of Excellence which incorporates two HLIs to support AI technology initiatives in T/L processes (Butcher *et al.*, 2021). Based on the aforementioned initiatives, it is obvious that HLIs have on the one hand established partnerships with large AI stakeholders for support, sharing expertise and infrastructures for the realisation and sustainability of AI technology in T/L processes.

4.2 Opportunities for the Use of AI Technology in the T/L Processes in SSA

In the world today, at least all tasks can be automated, and run by AI technology (Popenici and Kerry, 2017). In T/L processes, AI technology has the potential to structure human resources for the sake of the provision of quality services at any time in HLIs. It facilitates conventional T/L processes in congruence with the time and space of the instructors and learners (Ocana-Fernandez, Valenzuela-Fenandez & Garro-Aburto, 2019). Hence, AI technology enhances students' academic achievements (Benitti, 2012), draws interest, enables communication and collaboration, and engages students in the T/L processes (Popenici & Kerry, 2017). A study by Merdan,

Lepuschitz, Koppensteiner, and Balogh (2017) avers that AI technology impacts students in their critical thinking, problem-solving techniques, teamwork, reading, and writing skills. AI technology enables collaborative T/L environments and gives feedback on the outcomes of the processes (Kory & Breazeal, 2014).

AI technology enables instructors and students to develop individualization in which they can engage in T/L processes on their own through simulators and tutorial models and new training modalities (Gisbert & Esteve, 2016; Ocana-Fernandez, Valenzuela-Fernandez, Garro-Aburto, 2019). The study by Butcher *et al.* (2021) raises a lot of concerns about whether developing countries, SSA, and stakeholders such as governments and organizations are prepared and willing to reap the benefits of AI and other emerging technologies.

4.3 Challenges of the Use of AI Technology in the T/L Processes in SSA

Notwithstanding the opportunities of AI technology in T/L processes, studies indicate many specific challenges concerning the use of AI technology in SSA. The challenges are grouped into five categories which are; lack of financial resources, inadequate skills, inadequate ICT infrastructure, gender inequality, and lack of governing instruments (Butcher *et al.*, 2021; Pillay, 2020; Nwaodike 2020; Travaly & Muvunyi, 2020; Onaolapo & Onifade, 2020; Butcher *et al.*, 2021). Studies indicate that most SSA countries lack sufficient financial resources to support the use of AI solutions for T/L. Butcher *et al.* (2021), for example, established that SSA lacks funds for setting up AI-related facilities, for supporting AI research and capacity. Furthermore, The World Wide Web Foundation (2017) opines that not only do universities in SSA have difficulties in securing funding for their AI infrastructures and research but also governments are operating in resource-constrained and sometimes corrupt environments.

The second challenge facing SSA in using AI technology in T/L processes is inadequate skills. The study by Pillay (2020) indicates that SSA lacks the technical expertise to establish and run AI technology for T/L. Nwaodike (2020) reveals that two of the key barriers to digital adoption in SSA as in other developing countries is the lack of education and skills. Lack of relevant technical skills, particularly for young people is indicated in Travaly and Muvunyi (2020) as a growing threat as far as the use of AI in teaching and learning is concerned. AI technology requires ICT infrastructures with robust networks, immense computing power, and stable Internet connections (Yahya, 2017). Unfortunately, SSA suffers from inadequate ICT infrastructure to support AI use in T/L (Onaolapo & Onifade, 2020; Butcher *et al.*, 2021). Pillay added that in connection to insufficient ICT infrastructure, SSA lacks even complementary infrastructure like electricity and roads. Furthermore, most HLIs in SSA have ICT policies but lack AI policies which would create clear directions on the application of AI for T/L processes (Onaolapo & Onifade, 2020).

5. CONCLUSION

AI technology impacts T/L processes in HLIs bringing opportunities, challenges, and potential futures that require critical analysis. This is because T/L processes are human-centric and not AI technology-centric entities. This means humans can identify opportunities, challenges, and potential future of AI technology to nurture creativity, and engage humans in humanistic values linked with environments and

cultures in T/L processes. For effective human-AI interaction and collaboration, further studies are paramount to compare the effectiveness of AI technologies in developing countries and SSA in particular compared to other T/L approaches.

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