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THEORISING MACHINE LEARNING AS AN ALTERNATIVE PATHWAY FOR HIGHER EDUCATION IN AFRICA

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ABSTRACT

Machine learning technology is currently a new frontier for higher education globally, and the African higher education system needs to change in tandem with this technological trend in order to combat challenges faced by the system. These challenges include lack of institutional research to discover new knowledge, unfavorable methods of instruction, especially the language conflict, access to education for marginalized and isolated communities, high dropout rates, depleted infrastructure and unavailability of resources, overpopulated classrooms, and a biased grading system. This paper discusses alternative machine learning solutions to these challenges faced by the African higher education system, in order to ensure that students develop the skills needed to thrive in this digital era. Findings reveal three key technological solutions that can provide alternative solutions to these challenges, and they include customized/personalized learning, predictive analytics and digital administrative management, and virtual assistance. This paper concludes that for Africa, Catching up with the world goes beyond adopting these new innovations to facilitate learning. Recommendations include rethinking the content of the African curriculum, developing an unbiased education system, and adopting a suitable medium of instruction.

Contribution/Originality: This study documents the major challenges plaguing the higher education system in Africa, and proffers a pathway to a better system using machine learning solutions. Most importantly, it finds that these computerized technologies can be applied using Africa's unique indigenous knowledge.

1. INTRODUCTION

Learning simply refers to gaining knowledge by study, instruction, or experience (Nilsson, 2005). Machine learning can now refer to teaching machines to learn, and think. According to Wen, Li, Lin, Hu, and Huang (2012) by using algorithms that iteratively learn from data, machine learning allows computers to find hidden insights, without being explicitly programmed where to look. The origin of machine learning can be traced back to three centuries ago, when early scientists and inventors laid the groundwork for recent computing inventions. Several inventions such as, an arithmetic machine by Blaise Pascal in 1642, the binary code system by Gottfried W. Leibniz in 1679 and, the Boolean logic by George Boole in 1842, which created a form of algebra where all values can be reduced to "True" or "False". More recent inventions in this field are Kinect by Microsoft in 2010, which allows people to interact with computers through movements and gestures, Google Brain by Jeff Dean in 2012, which focused on pattern detection in images and videos, and later used to detect objects in YouTube videos. Also, LipNet in 2016 by a team at Oxford, which can identify lip-read words with 93.4% accuracy, and many other innovations. Machine learning has been around for decades, and computers have kept learning to improve and think like humans

do. Technology in the works spans everything from boosting security with biometric data, to improving in store retail experiences, and diagnosing diseases. Today, machine learning powers tools such as self driving cars, fraud detection, voice activated assistants, and social media feeds. In fact, businesses have realized that machine learning will increase calculation potentials, and are investing heavily on research in these areas so as to stay ahead of the competition.

The educational sector has not been left behind as new teaching, and learning solutions are currently being tested globally. Multi -model systems that can be used for student retention, student-teacher paring, student success prediction, grade prediction, and many other predictive scenarios are in the works (Lapierre, 2018). This cutting edge science has been projected to bring a lot of changes to the field of education, such that computers can deliver customized lectures to each student taking significant workload off educators. Educators will also not need to wait until a test or quiz is done, to evaluate the student's ability, as online programs will be designed to grade a student's work instantly, and present educators with formative data immediately. The advancement of machine learning in the education sector is limitless, with great promises for the future of global education (Mcguinness, 2018). The African continent often lags behind the rest of the world when it comes to embracing innovation. However, machine learning is increasingly being accepted as a solution to tackling a whole lot of issues combatting the higher education sector. From issues arising from overpopulated classrooms, to problems of no access to classrooms at all, heavy teaching load, lack of research-experienced faculty, and information and communications technology infrastructure, machine learning techniques can be used to address most challenges that bedevil the higher education sector in Africa, creating alternative solutions that are unique and significant.

Therefore, this paper intends to explore the different ways machine learning can address the challenges currently faced by higher education institutions in Africa, presenting its several beneficial techniques, as an alternative to a system limited by manual and out-dated educational practices. To this end, the next section reveals conceptualizations of machine learning by several scholars, a brief background of the current position of higher education in Africa, and the challenges faced by this sector. Discussions will subsequently be made on the need to introduce, and utilize machine learning as an alternative to attacking these challenges and the role it will play in bringing higher education in Africa to global par.

2. BACKGROUND

This section introduces different definitions for the term machine learning, while explaining the need for its adoption in the higher education system in Africa. It further discusses the several challenges facing higher education institutions in Africa, after giving a brief overview of its history and current state, in a bid to trace the origin of the recent struggles faced by these institutions of learning.

2.1. Conceptualizations of Machine Learning in Higher Education

Machine learning as defined by Authur Samuel who coined the term, is the ability of a computer to learn without being explicitly programmed. This implies that the computer possesses the ability to think, and do what humans can do. Essinger and Rosen (2011) argue that machine learning is a subfield of artificial intelligence, which evolved out of the need to teach computers how to automatically learn a solution to a problem. Offering an alternative definition, Tom Mitchell postulates that , "a computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P with experience E." (Faggella, 2019). It is simply the science of getting computers to learn and act like humans do, and improve their learning overtime in autonomous fashion, by feeding them data and information in the form of observations, and real world interactions. Dr. Yoshua Bengio, the machine learning godfather, defines machine learning as part of research on artificial intelligence that seeks to provide knowledge to computers through data, observations and interacting with the world. The fundamental goal of this algorithm is to successfully interpret data that it has never

seen before. These algorithms can be applied to different domains, such as web search, computational biology, finance, E-commerce, space exploration, robotics, information extraction, debugging, social networks, etc. (Faggella, 2019).

The machine learning technology is currently a new frontier for higher education globally. Higher education is no longer about teaching of text, or requiring students to memorize manuscripts within the four walls of a classroom. Today's classrooms use digital resources, and students' performance can now be predicted. The teaching and learning process have become dynamic, owing to the advancement in global technology that is providing options such as, customized and personalized learning, efficient and accountable grading systems, and several other algorithms that improves the effectiveness of the learning process (Nafea, 2018). As stated by Kucak , Juricic, and Dambic (2018) "machine learning based assessment provides constant feedback to teachers, students and parents about how the student learns, the support they need and the progress they are making towards their learning goals." Drawing from the conclusions of Essinger and Rosen (2011) through the application of machine learning techniques, higher education students in Africa will be exposed to multi-interdisciplinary fields simultaneously, such as engineering, mathematics, computer science, economics, biology and photography. Usual educational operations will become easier, faster and, more efficient compared to when they were manually done. Adopting a machine learning-centric data-science approach, as a tool for administrators and faculty, is a game changer for higher education in Africa.

2.2. Higher Education in Africa: Past to Present

In Africa, higher education encompasses all post-secondary and tertiary institutions of learning. In the words of Newman (1910):

It is a place where inquiry is pushed forward, and discoveries verified and perfected, and rashness rendered innocuous, and error exposed, by the collision of mind with mind, and knowledge with knowledge.

At these learning and teaching institutions, knowledge is acquired with a certain degree of freedom and independence, with the purpose of preserving, discovering, and combining ideas and skills for the material use of the society. As defined by Alemu (2018) "modern higher education is defined as an organized tertiary learning and training activities and institutions that include conventional universities such as arts, humanities, and science faculties and more specialized institutions in agriculture, engineering, science, and technology... also includes institutions like polytechnics and colleges of education." These institutions of learning are the central producers of official and legitimate knowledge in any society. Odora Hoppers (2013) postulates that it is the most powerful level of the education system in any country. This is because these institutions of learning are agents for the growth of knowledge that has the power to change their host societies, and the world at large.

History reveals that Africa possessed ancient 'deep rooted and long experience' institutions of higher learning before colonialism; the oldest university still existing in the world is Egypt AL-AZHAR. These indigenous places of learning were rooted in African cultural and intellectual soil and climate (Alemu, 2018). Pre colonial higher education in Africa constituted of scholars with responsibilities to cultural, political and socio-economic issues. Then came the colonial masters, who created institutions of higher learning between the periods of 1930-1960. These institutions were imperfect clones of higher education institutions in Europe, and were considered as campuses of certain institutions in the colonial country. Woldegiorgis and Dovenspeck (2013) argue that the colonial era disconnected the continuity of African indigenous institutions, replacing them with Eurocentric institutions and models. For the colonialists, higher education was also an instrument of facilitating their administration, instead of enlightening the African societies. Therein lays the origin of the struggles, faced by modern institutions of higher education in Africa.

Today, all African nations are 'free' from their colonial masters, but the education sector still struggles partly due to some inherited structures, and programs that have no relevance to the needs of Africans at this time. Higher

education institutions in Africa combat with a wide range of issues, which will require solutions for repositioning and realignment to ensure its relevance to the global economy.

2.3. 21st Century Challenges of Higher Education within the Context of Study

The era of the 21st century has been widely recognized as the era of new knowledge, implying that institutions of learning are central to the future. For Africa, this is a pointer to the fact that its success politically, culturally and economically is dependent on the strength of its post secondary sector which will play a central role. The significance of these institutions of higher learning is evident in their ability to create, and discover new knowledge through research, which can be applied to solving existing or projected issues that plague society. This is not the case for most African nations as research is a neglected area of study in African higher education institutions Mafenya (2014). Investment in research is of great importance to institutions of higher learning, because it contributes to the base of knowledge, and creates the path to new innovations. For Africa, lack of funding of institutional research is the common reason for this drawback as research is dependent on availability of resources, for the provision of facilities, infrastructure and scholars with the intellect and creativity to train students to innovate. Most African governments are not interested in the research activities of higher education institutions, and therefore do not invest (Mafenya, 2014).

Mafenya (2014) further states that the value placed on research activities should improve, challenging African scholars to take advantage of new global opportunities to solve the many issues plaguing the continent. The structure of the global education system is changing in areas such as curriculum planning, methods of teaching and others, with the advancement of technology, thus significantly affecting the eventual output of the education system. African higher education institutions should therefore encourage research activities as its dividends are societal growth, technological improvement, and societal development. To catch up with the world, collaboratory and integrated research will require African students to cross-boundaries, share information, to generate new integrative knowledge. Achieving this feat with Africa and the globe on a balanced scale requires unique contributions, and communication which is hampered by the language problem. In fact, most African researchers show no interest in generating new knowledge, and most materials used in higher education institutions in Africa are in western languages. The language barrier is an inherited limitation, and is multidimensional, as it is the root cause of other academic challenges (Mafenya, 2014; Teferra & Altback, 2004).

In the forefront of the challenges faced by higher education institutions in Africa, is the medium of instruction utilized for the teaching and learning process, especially language. Over 2000 languages have ben identified with the African continent today, buy only about 12% are commonly spoken as a result of colonialism, which devalued indigenous African languages. Out of 54 countries in Africa, 21 nations use French, 20 use English, 5 use Portuguese and, 1 use Spanish (Warschauer 2010). Existing forms of local languages used in learning institutions were replaced with the language of their colonial masters by most African nations. As stated by Malone (2016) 40% of children do not have access to education in a language they understand and this negatively affects their learning. Most African nations prioritize official languages as the medium of instruction, and these are not often the languages these children speak at home. When home and school languages differ, it affects the performance of students negatively (Malone, 2016). This is evident because using mother tongue enhances classroom participation, decreases attrition, and encourages the inclusion of family and community members in the learning process of the student. It therefore goes to show that the language problem inadvertently excludes some African students from the higher education system (Teferra & Altback, 2004) argue that:

African universities rely on the knowledge system that has been conceived, developed, and organized based on western languages. The western world produces the majority of knowledge conveyed in those languages. African universities do not have the capacity to generate enough knowledge of their own... most books, journal, databases, and other resources that are used in higher education institutions are imported, and these are communicated in western languages.

This language conflict has contributed to the decline of higher education in Africa, but if properly handled will improve access to a wider African community. If students in institutions of higher learning can communicate beyond these barriers, especially with the teeming population that the continent boasts of, it will increase the learning speed, encourage access to information, and unlocked opportunities.

Another major problem of Higher Education Institutions in Africa is providing access to education for their teeming population. Not just access to education, but access to quality and standard education. As at independence, most African nations were left with a small or non existent academic system, because the colonial masters ensured that access to higher education was available only to a few elites in their bid to tighten their grip on their colonies. As at 2007, student enrolment ratio into higher education was still the lowest in the world (Africa – America Institute (AAI), 2015). The AAI (2015) report card further reveals that only 6% of young people enrolled in higher education institutions in Africa compared to a global 26%. The difficulty of providing higher education to poor communities far from these institutions of learning played a role in these poor figures, as most enrollees had to travel far away from their families to access these institutions. Namibia has the reputation of Africa's poster child for progress in education due to its government's investment of 20-25% of its budget in education, but they still combat with access to education for students living within its vast areas of desert, and hard-to-reach communities (Houlou , Bellamy, Malpel, & Sousa, 2012).

Africa is a well populated continent and has continued to grow; this can either be a demographic opportunity, or a demographic disaster. Between 2000 and 2010, higher education enrolment increased from 2.3million to 5.2milion (AAI, 2015). Kenya for example had just 1000 enrollees in institutions of higher learning as at 1963, but that figure rose to 276,349 students recorded in 2016. Lecture halls are now overcrowded, and statistics show that on the average, there are 50% more students per professor compared to the global average. Infrastructure and resources for institutions of higher education have since suffered lack, despite an increase in demand for higher education. More Africans enroll into these institutions which can only cater for a few numbers of students, thereby straining its resources, facilities, and staff. Most public higher education institutions in Africa enroll students far beyond what their resources can cater for. The number of students and institutions hardly correlate, affecting the standard of education obtainable, or leaving these students with no education at all (Houlou et al., 2012) (AAI, 2015).

Even though demand for access to higher education is growing, there are lots of students dropping out before the completion of their study. These inadequacies of infrastructure leads to high dropout rates, as programs take longer than required to be completed thus, discouraging scholars amongst other reasons. Yoganathan (2017) states that as at 2015, 24% of enrollees into higher education dropped out in their first year, 14% subsequently dropped, and 48% never graduated. The problem of balance between inputs and relevant outputs, i.e., the right balance of enrolled and graduated students thus emerges. As recognized by Mokoena and Materechera (2012) the dropout rate of first year students in South Africa's institutions of higher learning was a trend, and their study concluded that it was a result of under preparation for higher education. They advised that higher education institutions should identify the strength and weaknesses of these students, and develop creative strategies to provide support and assistance. It is clear that the increasing demand for higher education in Africa cannot be met using face-to-face delivery of education. Other approaches have to be explored to complement the already saturated system.

According to Munene (2016) the combination of high enrolments and inadequate resources is a recipe for disaster. Resources have been stretched, such that the kind of education obtained is compared to no education at all. African scholars now seek for better education in foreign institutions of higher learning, resulting to a brain drain situation for the continent. Statistics show that in 2008, 223000 students from sub-Saharan Africa enrolled to study in higher education institutions outside their home countries (AAI, 2015). Polgreen (2017) decries;

The best African universities, the grand institutions that educated a revolutionary generation of nation builders and statesmen, doctors and engineers, writers and intellectuals are collapsing. They are victims of overcrowding... the decrepitude is

forcing the best and brightest from countries across Africa to seek their education and fortunes abroad and depriving dozens of countries of the home-grown expertise that could lift millions out of poverty.

The implications of these movements are clear as most of these scholars graduate, and do not return home. A 2013 United Nations report shows 1 in 9 Africans with a tertiary education, live in developed countries in Europe and America. The World Economic Forum's Global Competitiveness Report (2014-2015) showed Burundi as the African country least able to hold on its top talent, Algeria, Mauritania, Chad, and Guinea were also top on that list. These foreign institutions for standard learning utilize several technological innovations (like machine learning and artificial intelligence) in their teaching and learning process, and they have continued to advance. Other challenges plaguing the higher education system in Africa includes lack of funds, government interference in school administrative activities, excessive non-academic staff, and gender imbalance (Teferra & Altback, 2004). There is therefore a need for the higher education system change to occur in tandem with technological changes.

3. DISCUSSION

In this section, the solutions presented to combat the challenges outlined in the previous section, using machine learning techniques are elaborately discussed.

3.1. Machine Learning in the African Higher Education Landscape

Globally, machine learning is already infiltrating every corner of higher education, with mind blowing technologies that are efficient, and effective in the educational process. Countries like China have set these machine learning technologies as strategy for an educational revolution, that will see the nation attaining the position of the number one artificial intelligence hub by the year 2030 (Jing, 2018). Previous discussions in this paper already show that machine learning generally involves developing computer programs that can access data, and use them to learn and make predictions by themselves. The key to machine learning is data; algorithms are designed to learn from this data, and make predictions about the subject. These machines can examine numerous data fields faster, and present information for interpretations. To this end, machine learning can provide alternative solutions to the challenges facing higher education in Africa via three key technological innovations: customized/personalized learning, predictive analytics and digital administrative management, and virtual assistance.

3.2. Customized/Personalized Learning

Machine learning can help construct the individual learning plans of students based on their strength, weaknesses, activities, and learning preference. Customized/personalized learning is a key area in which machine learning can impact African higher education system, as it involves understanding the current learning position of a student, and creating personalized plans to improve it Sagenmuller (2017). Personalized learning platforms can create systems that respond to individual student pace and progress, access student's progress, and recommend solutions to their academic struggle. According to Lynch (2019) "personalized learning is an educational model where students guide their own learning, going at their own pace, and in some cases, making their own decisions about what to learn." This implies that this technique creates effective learning plans that encourage students, as learning is now made easy. These plans strengthen identified students weaknesses, boosting retention rates, and reducing drop out rates.

Adjusting learning based on individual student's needs should be a priority for African higher education, so that students are presented with challenges they are ready for, gaps in knowledge can be identified and, challenges that will gear the student in the right direction will be formulated.

3.3. Predictive Analytics and Digital Administrative Management

As opposed to manual and intermediate computerized methods utilized by the African higher education system, machine learning can drastically improve the system, by simply finding patterns that would be impossible via human approach. Using these patterns, machine learning and statistical modeling techniques can quickly, and accurately identify students at-risk of failure or dropout, then use this insight to create solutions for better outcome. Huber (2019) states that, "predictive analytics is a form of advanced analytics and modeling that uses data to make predictions about the future." This implies that using this adaptive technology, machine learning can analyze a students' performance in real time, and modify teaching methods based on that data. It can be used to curb the drop out rate, as cumulative records of the student can predict academic failure or dwindling interest in academics, and provide timely interventions. As stated in a UNESCO (2019) report, Microsoft is already working on a machine learning solution that captures student data containing grades, health records, etc. This data is analyzed to help teachers and educators predict dropout probability, and enable them provide additional assistance to these students at risk, and draft other preventive measures.

In tackling administrative issues, machine learning can automate the delegation of duties, support complex decisions, design new solutions, and undertake complex task assignment, scheduling and planning techniques (Sagenmuller, 2017). Repetitive tasks such as enrolment, marking and grading students' tests can become automated, saving the time and energy of educators. China recently experimented on a machine learning designed essay grading system, which graded the work of 60,000 schools for automatic essay correction, with a level of precision matching humans in 92% of the cases (UNESCO, 2019). Educators spend a lot of time and resources on administrative tasks, and innovations like this which can handle these tasks frees up time for the teacher to enable them focus on student guidance. Machine learning can therefore promote student success, improve retention, streamline enrolment, grade tests, and better manage resources in the African higher education landscape.

3.4. Virtual Assistance

Machine learning can also improve access to education, encourage collaborative learning, and also tackle the language limitation adversely affecting the higher education system in Africa. As stated by Marr (2018) machine learning can make the classroom more accessible to students who speak different languages. There are language interpreting and processing software that promote cross-communication, and improves comprehension. Using natural language, students can interact with a computer through voice or chat, and receive assistance (Sagenmuller, 2017). It also promotes collaborative learning in situations where learners are not physically in the same location, with techniques such as shallow text processing (UNESCO, 2019). This implies that African students residing in different African countries can collaborate and study together, without having to travel, thus providing crowdsourcing solutions. The brain drain challenge can also be handled as African intellectuals do not need to relocate to foreign nations to obtain standard education, as these courses can be handled online digitally from their resident location.

As stated by UNESCO (2019) these technologies can also be used to ensure equitable and inclusive access to education, to marginalized people and communities. Africans living in isolated communities can now be reached and provided access to appropriate learning opportunities. Schittek-Janada, Mattheos, Lyon, and Altstrom (2001) also postulates, there are Computer Assisted Learning (CAL) technologies, which create alternatives to support students' learning strategies, with digital and artificial intelligence technology. Intelligent Tutoring Systems are also part of the new technological possibilities to expand educational learning in Africa (Nye, 2015). Liulishuo is a machine learning technology created by the Chinese government; it is an adaptive platform that teaches English language to 600,000 students at the cost of a single teacher (UNESCO, 2019). This implies that teachers will now have more free time on their hands, and resources are better managed.

Some African countries are already trying to catch up with the world. For example, Strattmore University in Kenya established a research center that seeks to promote emerging technologies such as big data, artificial intelligence(AI), block chain technology, cyber security, internet of things (IoT) and cloud services(MPID, nd). In 2013, in Cape Town South Africa, a machine learning solution that provides personalized learning to teachers, students, and content creators was introduced. It uses deep analytics to give teachers insights into the proficiency level of their students. Similar innovations in South Africa include Get Smarter, Funda, Siyavula, and Re-Think education. Uganda has introduced Skool Desk, and as at 2016 in Kenya, a mobile platform filled with lessons based on the national curriculum standards was introduced. This platform called M-Shule delivers these lessons via SMS, adapts to each students skills and abilities, and analyses their performance, so as to recommend solutions to their struggles (UNESCO, 2019).

4. CONCLUSION AND RECOMMENDATION

The African higher education sector must quickly adapt this growing trend, providing new frameworks for students to develop skills needed to thrive in this digital era. Catching up with the world goes beyond adopting these new innovations to facilitate learning. Africa needs to rethink the contents of its curriculum, with attention on unique indigenous knowledge, and techniques that can be advanced using these technologies, and are relevant to life in Africa. The medium of instruction in higher education institutions needs to also change with the intent of carrying Africa's whole population along, without the limitation of using foreign languages as the required means of communication. The curriculum used by these higher institutions of learning should be restructured to incorporate training, and developing problem solving skills using computerized technologies and methods. A new curriculum that is planned around the advancement of artificial intelligence, and machine learning should be adopted thereby making African scholars digitally aware and literate.

According to Antoninis and Montoya (2018) "digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and, create information safely and appropriately through digital devices and networked technologies for participation in economic and social life." Creating a digital literate environment will imply laying out a strategic framework to revamp the current higher education system, with focus on pertinent issues such as, creating research laboratories to study how these machines and technologies can be helpful to the continent, and increase incentives for researchers in this field to make it attractive. Finally, it is common knowledge that the grading system in most higher education institutions in Africa has become biased, as some students are issued grades they didn't earn, therefore abusing the system. More recently, BBC Africa Eye shocked the world with a documentary from an undercover investigation by one of its agent, revealing the sexual harassment that occurs behind closed doors in some of West Africa's prestigious universities, where grades are exchanged for sex (British Broadcasting Corporation (BBC), 2019). Machine learning can curb this because for one, machines are blind, and thus test results cannot be rigged to favour a particular student. This means that the African higher education system can become totally unbiased.

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REFERENCES

Africa – America Institute (AAI). (2015). State of education in Africa report 2015. Retrieved from: https://www.aaionline.org/state-of-education-in-africa-report-2015-released/. [Accessed September 28, 2015].

Alemu, S. K. (2018). The meaning, idea and history of university/higher education in Africa: A brief literature review. *Forum for International Research in Education, 4*(3), 210-227.

Antoninis, M., & Montoya, S. (2018). A global framework to measure digital literacy. UIS, UNESCO. Published March 19, 2018. Retrieved from: http://uis.unesco.org/en/blog/global-framework-measure-digital-literacy.

British Broadcasting Corporation (BBC). (2019). Sex for grades: World reacts to BBC Africa eye documentary. World News. Retrived from: http://www.bbc.com. [Accessed October 8, 2019].

Essinger , S. D., & Rosen, G. C. (2011). An Introduction to machine learning for students in secondary education. *2011 Digital Signal Processing Education Meeting. DSP/SPE 2011*, 243-247.

Faggella, D. (2019). What is machine learning? Emerj, Published February 26, 2020. Retrieved from: http://emerj.com/ai-glossary-terms/what-is-machine-learning/.

Houlou , N., Bellamy, C., Malpel, J., & Sousa, G. (2012). Equitable access to quality education: Challenges in Namibia. European Union, Capacity4dev. Retrieved from: https://europa.eu/capacity4dev/article/equitable-access-quality-education-challenges-namibia.

Huber, A. (2019). Higher education predictive analytics: The future in the digital age. Jobzology, Published May 22, 2019. Retrieved from: http://jobzology.com/higher-education-predictive-analytics.

Jing, M. (2018). China wants to bring artificial intelligence to its classrooms to boost its education system. Science & Research, South China Morning Post. Published October 14, 2017. Retrieved from: http://www.google.com/amp/s/amp.scmp.com/tech/science-research/article/2115271.

Kucak , D., Juricic, V., & Dambic, G. (2018). *Machine learning in education- A summary of current research trends.* Paper presented at the Proceedings of the 29th DAAAM International Symposium, Pp.0406-0410, B. Katalinic (Ed.), Published By DAAM International.

Lapierre, J. (2018). Machine learning in higher education. Explorance. Retrieved from: http://www.explorance.com. [Accessed July 26, 2018].

Lynch, M. (2019). 6 ways machine learning will revolutionise the education sector. The Tech Edvocate, Published March 6, 2019. Retrieved from: https://thetechedvocate.org.

Mafenya, P. N. (2014). Challenges faced by higher education institutions in research skills development: A South African open and distance learning case study. *Mediterranean Journal of Social Sciences*, *5*(4), 436-442.

Malone, S. (2016). *MTB MLE resource kit: Including the excluded: Promoting multilingual education.* Paris, UNESCO: Bangkok, UNESCO Office Bangkok.

Marr, B. (2018). How is AI used in education… real world examples of today and a peek into the future. Forbes, July 25, 2018. Retrieved from: https://www.forbes.com.

Mcguinness, W. (2018). The benefits and the limitations of machine learning in education. Getting Smart, February, 2018. Retrieved From: http://www.gettingsmart.com/2018/02/the-benefits.

Mokoena , M., & Materechera, E. (2012). Underprepared students: How best can they be creatively supported? *International Journal of Arts & Sciences*, *5*(5), 23-31.

Munene , I. (2016). Kenya's universities are in the grip of a quality crisis. The Conversation, Published February 17, 2016. Retrieved from: http://theconversation.com/kenyas-universities-are-in-the-grip-of-a-quality-crisis/.

Nafea, I. T. (2018). Machine learning in educational technology. Machine learning advanced techniques and emerging applications: Hamed Farhadi, Intech Open. Retrieved from http://dx.doi.org/10.5772/intechopen.72906.

Newman, H. (1910). *Essays, English and American, with Introductions, notes and illustrations.* New York: P.F.Collier and Son.

Nilsson, N. J. (2005). Introduction to machine learning: An early draft of a proposed text book. Retrieved From: https://www.ai.stanford.edu>mlb.

Nye, B. D. (2015). Intelligent tutoring systems by and for the developing world: A review of trends and approaches for educational technology in a global context. *International Journal of Artificial Intelligence in Education*, *25*(2), 177-203. Available at: https://doi.org/10.1007/s40593-014-0028-6.

Odora Hoppers, C. A. (2013). *Higher education in Sub-Saharan Africa: The past, the present and the future.* Paper presented at the Keynote Address at Ljubljana Conference on Higher Education Reform, 24th October, 2013.

Polgreen, L. (2017). Africa's once-great colleges are overcrowded and crumbling. The NewYork times. Retrieved from: https://www.nytimes.com. [Accessed May 20, 2017].

Sagenmuller, I. (2017). How artificial intelligence helps higher education management. Technology for Education Blog, January 19, 2017. Retrieved from: https://www.technologyforeducation.com.

Schittek-Janada, M., Mattheos, N., Lyon, H., & Altstrom, R. (2001). Computer assisted learning. A review. *European Journal of Dental Education: Review Article*, *5*(3), 93-100.

Teferra, D., & Altback, P. G. (2004). African higher education: Challenges for the 21st century. *Higher Education Studies*, *47*(1), 21-50.

UNESCO. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development. *UNESCO Working Papers on Education Policy 07*.

Warschauer , M. (2010). Language identity, and the internet. In B.Kolko, L. Nakamura & G. Rodman(Eds) Race in Cyberspace (Vol. 2000, pp. 151-170). New York: Routledge.

Wen, J., Li, S., Lin, Z., Hu, Y., & Huang, C. (2012). Systematic literature review of machine learning based software development effort estimation models. *Information and Software Technology*, *54*(1), 41-59. Available at: https://doi.org/10.1016/j.infsof.2011.09.002.

Woldegiorgis, E. T., & Dovenspeck, M. (2013). The changing role of higher education in Africa: A historical reflection. *Higher Education Studies*, *3*(6), 35-44.

Yoganathan , V. (2017). High drop out rates, technology to the rescue? University World News, Published 14th April, 2017. Retrieved from: https://www.universityworldnews.com.