Teaching and learning contextual issues in African Higher Education 4.0: Lessons for sustainability

Chinaza Uleanya
Department of Education Leadership and Management
University of Johannesburg
Johannesburg, South Africa
chinazamoses90@gmail.com
Mofoluwake Oluwadamilola Uleanya
Communication Science
University of Zululand
KwaZulu-Natal, South Africa
mofoluwaket@gmail.com
Samuel Oluwatobi Taiwo
Business Management
University of Fort Hare
Eastern Cape, South Africa
samueloluwatobi71@gmail.com
Olukayode Ayodele Oki
Information Technology Department
Walter Sisulu University
Eastern Cape, South Africa
ooki@wsu.ac.za

Abstract

This study systematically reviews the contextual issues of teaching and learning in African higher education system. Qualitative method was adopted following search on Web of Science and Scopus where 451 corpus of articles were retrieved and a bibliometric analysis presented. The findings of the study showed that among the contextual issues in African higher education 4IR are improvement, leadership, reliability, ICT, pedagogical content knowledge, skills, misconceptions, competence, student engagement, access, technology, supply chain management, innovation, attitudes, discovery, and employment. The study recommends that to aid sustainability, there is need for African higher education to be supported by stakeholders in ensuring inclination to the demands of industry 4.0. Such is envisaged to promote the relevance of the higher institutions of learning and sustainable development in the continent.

Keywords: African higher education (AHE), industry 4.0 (4IR), teaching and learning, sustainability

Introduction

Industry 4.0. is being explored in various sectors and ways based on different perceptions of experts, entities and organizations. For instance, according Nokia (n.d) reporting on the statement of the individual described as the father of Industry 4.0. in person of Henrik von Scheel, for Industry 4.0 to succeed, there is need for people and organizations to "*think value*, not tech; *think people*, not tools; and *set clear targets from the start* (par. 1, italics added for emphasis)." The question remains, how well are the three identified factors duly considered by individuals and organizations, especially in underdeveloped and developing (African) nations? Meanwhile, the quest for industry 4.0. according to the United Nations Economic and Social Council (2022) is on the increase. However, many African nations are scrambling to meet up with the demand of the era (Asiimwe & de Kock, 2019) especially in the area of education. This is attributed to different factors such as lack of infrastructure, insufficient funding, lack of personnel to train the younger generation (Kayembe & Nel, 2019). According to Adam (2019) as well as Manda and Dhaou (2019), factors hindering the nations in the African continent from preparing for the Fourth Industrial Revolution regardless of its immense importance/benefits include skills challenge, socio-economic issues, access to technological infrastructures and facilities, access to quality education, poor implementation of policies, socio-historic issues, lack of comprehensive legal framework and poor institutional capacity targeted at addressing cybercrime, among others. Meanwhile, education has been identified as one of the ways by which challenges of 4IR can be addressed (Hameed & Hashim, 2022), however, considering the issue of quality in the provided education in African nations constitutes a setback (Manda & Dhaou, 2019). According to Hameed and Hashim (2022), one of the major challenges affecting practices of the Fourth Industrial Revolution assisting to address the prevailing challenges of the era is the integration of technology in teaching and learning. This suggests that teaching and learning in the era of industry 4.0 is a major subject matter that is worth of investigating.

On the other hand, teaching and learning in African higher education according to the director of UNESCO-IICBA, in person of Ngu (2007), "…seeks to make sense of the many changes that are taking place in learning and teaching in higher education in the continent and offers insights into where teaching and learning might be moving in the future (p. 1)." This is suggestive that African higher institutions of learning from time past have been saddled with the responsibility of giving insights and direction to teaching and learning activities in the continent even to the future. This had led to different discussions on access (Chaka &

Govender, 2017; López-pérez, Pérez-lópez & Rodríguez-ariza, 2011; African Development Bank (ADB), 2008). However, Tewari and Ilesanmi (2020) posit that "The quest to get many people into higher education often crowds out the need for quality teaching and learning achievement if not backed up by resources (p. 1)." In congruence, Uleanya, Gamede and Kutame (2020) following the findings of their study which was situated in an African though rural context, describe such as being irrelevant when the needed resources are unavailable. This suggests the need for quality in the provided education in African higher institutions of learning. Gwaravanda and Ndofirepi (2021) considering the African space, call for the need "…for improvement of teaching and learning …; critical thinking, decolonisation, transformation, gender balance, drawing from ubuntu, Africanisation, gender balance and inclusivity (p. 1)." Suffice to state that teaching and learning in the African higher education space requires some forms of enhancement in the form of quality, while projecting features of the African continent. Ng'ambi, Brown, Bozalek, Gachago and Wood (2016) clamouring for the need for quality education echo the inclusion of technology in teaching and learning activities in African higher education. In support of this, Yende (2021) reporting on transitioning towards the 4IR states that "The fourth industrial revolution has become the main driving force in improving higher education worldwide (p. 55)." This indicates that inclusion and embracing of technology which is a major tenet of the 4IR is expected to be of high demand.

Sequel to the foregoing on teaching and learning in African higher education and issues bordering around industry 4.0, the need arises for this study which explores the scholarly discourse of issues of the 4IR in the context of higher education in the African continent. The study is guided by the research question: What are the issues in teaching and learning in African higher education with regards to industry 4.0 presented in scholarly literature? This is in an attempt for the authors to possibly find out using a systematic review of literature approach the perceptions of scholars on issues bordering around teaching and learning in African higher education in industry 4.0.

Fourth Industrial Revolution (4IR)

The 4IR has gained attention in several nations, sectors, platforms and fields. However, divergent views have emanated as it is differently approached in different context thus, making it difficult to have a universal definition of the concept (Prisecaru, 2016). Critics have viewed the concept '4IR' which is synonymous to industry 4.0 as a fad that will soon fade while proponents argue that it is a concept that will perpetuate (Cetrulo & Nuvolari, 2019; Lee et al., 2018). Amidst the proponents still, some opine that the changes occasioned by Industry 4.0 is evolutionary while others contend that it is revolutionary hence, their use of the term fourth industrial revolution or 4IR (Rifkin, 2011; Schwab, 2016a; Ndung'u & Signé, 2020; Taiwo &

Vezi-Magigaba, 2021). Notwithstanding their convergence on the 4IR, some 4IR authors protest that its changes are inhumane in that the 4IR technologies will make many people redundant in the workplace thereby rendering them jobless and economically unproductive (Future of Jobs Report, 2018; Phillips, Seedat & Westhuizen; 2018). Notable in this regard is the view that the 4IR is more likely to be economically recessive than beneficial for African nations and other developing nations (Economist Intelligence Unit, 2018; Ndung'u, and Signé, 2020; Runde, Bandura, and Hammond, 2019). On the other hand, others advocate that irrespective of the nation, the 4IR holds great potential for economic growth provided that emphasis is placed on transformation through human capital development (Manda and Backhouse, 2017; World Development Report, 2019; Taiwo & Vezi-Magigaba, 2021).

The latter view on transformation through human capital development provides the framework upon which discussions around the 4IR role of teaching and learning activities in higher education hinges (Magwentshu, et al., 2019). This is because higher education plays the critical role of developing the skills, competencies, and knowledge possessed by the current and potential workforce for workplace relevance (Uleanya, Taiwo & Uleanya, 2021). Therefore, workforce relevance in the previous phases of the industrial revolution required transformation in teaching and learning activities (Xu, David & Kim, 2018). Considering the foregoing, the need for this systematic review on contextual issues in teaching and learning in African higher education in industry 4.0 cannot be overemphasised. Subsequently, this systematic review is structured as follow: conceptualization of terms, research methodology, findings and discussion, conclusion and recommendations.

Conceptualization of terms

African higher education: Africa is a continent which houses over 1 billion persons, of which half are projected to be below the age of 25 by the year 2050 (The World Bank, 2022). This implies that Africa has a growing rate of young people, thus, education is expected to be of high demand in the continent. Higher education is referred to as tertiary institutions, or institutions of higher learning. Therefore, in this study, African higher education is used to mean institutions of higher learning situated in nations in the African continent.

Industry 4.0: This is used to imply a novel phase in the Industrial Revolution which heavily focuses on connectivity (Agrawal, Eloot, Mancini & Patel, 2020), machine learning, interconnectivity, real-time data and automation (Oztemel & Gursev, 2020; Lepasepp & Hurst, 2021; Alcácer & Cruz-Machado, 2019). In the context of this study, industry 4.0 is used synonymously and interchangeably with Fourth Industrial Revolution which in some instances is represented as 4IR.

Critical Framing

The adopted framework for this study is epistemic access and success. This is based on the notion as put forward by scholars such as Menon and Motala (2022) and Le Grange (2020) that inclusivity in teaching and learning is on the increase and has become a subject of urgent priorities following the outbreak of the COVID-19 pandemic. Also, according to Le Grange (2020), the urgent need for inclusivity in teaching and learning has brought about new practices, pedagogies and modalities that are critical to educational development for the future. This is in alignment with the works of Maringe and Chiramba (2022), Oke and Fernandes (2020), Penprase (2018) who hold the view that with the advent of the Fourth Industrial Revolution, new practices, pedagogies and modalities would be critical for educational development. However, according to Menon and Motala (2022), Bishop-Monroe et al. (2021), Nasir, Ramli, and Som (2021), Motala and Menon (2020), several factors affect the new practices, pedagogies and modalties ranging from home or family circumstances, mental wellness, issues of university support, among others. Thus, the need for this study to systematically explore contextual issues with regards to teaching and learning in the 4IR.

Research methodology

Systematic differs from scoping review (Munn et al 2018; Peters et al. 2015). According to Arksey and O'Malley (2005), the process of a systematic review can be lengthy. Thus, it uses evidence(s) from various studies and study designs to proffer answer(s) to specific research question(s) (Peters et al. 2015; Soares, 2015). In the context of this study, in order to proffer answer to the identified question guiding this study, the five steps outlined by Khan, Kunz, Kleijnen and Antes (2003) were followed. The outlined steps are as identified and explained considering the procedure put forward by Khan et al (2003).

Step 1: Framing the question

Sequel to the first step outlined by Khan et al (2003), the researchers identified and framed the research question which served as guide for the study. This is also in accordance to the protocol put forward by the Louisiana State University (LSU) Libraries (2022) though as the second step to be followed in a systematic review after checking for existing reviews/protocols. Meanwhile, the researchers prior to outlining the steps followed ensured to check for the relevance of the study considering existing reviews/protocols. Following the step one outlined by Khan et al (2003), the authors considered the most suitable research question while taking into consideration the relevance of the study. The identified research question guiding the study is “What are the issues in teaching and learning in African higher education with regards to industry 4.0 presented in scholarly literature?”

Step 2: Identifying relevant work

This step requires researchers to find relevant materials which in this study comprise literature. For the purpose of this study, the researchers identified relevant literature following a search using specific key terms. The key search terms used for this study are: “Teaching and learning” AND “Africa” AND “Higher Education” OR “Tertiary institution” OR “Higher learning” AND “Industry 4.0” OR “Fourth industrial revolution” OR “4IR”. Following an online search on 31 October 2022 using Scopus, 17 articles were retrieved, thereafter a subsequent search was done on Web of Science (WoS) and a total of 4181 articles were retrieved. Scopus and WoS were adopted for the search following the submissions of Paperpile (2022) and Pranckute (2021) which states that Scopus and WoS are the largest bibliographic and commercial databases accommodating scholarly literature from different disciplines. A refine was done to include only education and educational research, 592 articles were retrieved. Further refine was done using the year of publication. Thus, the decade 2013 – 2022 was selected. This was based on the notion that it is a period in which 4IR has been more pronounced in the African continent. Further filter was done using language, as only English language was included, this brought about retrieval of 451 articles. English language was adopted because it is the ‘language of business, diplomacy, and international communication around the world (World population review, 2022, par. 6).’ Also, it is the language understood by the authors.

Step 3: Assessing the quality of studies

Khan et al (2003) states that “… quality assessment is relevant to every step of a review (p. 118)” This is required for all steps beginning from the step 1 which is the formulation of the research question as well as the study selection criteria (Step 2) up to the last step which is interpretation of the findings which is followed by ‘… inferences and making recommendations for future research (Step 5) (p. 118).” In this study, the authors assessed the quality of the study by ensuring that each of the researchers had a look and did critique what was done. For instance, one of the authors formulated the research question for the study, while the others critiqued it to ensure its suitability. The same protocol was repeated at the different stages (steps). Thus, as one of the authors worked on each identified step, the others provided criticisms where necessary in order for a consensus to be reached. Where there was a disagreement, all authors looked at the query together before finally reaching an agreement.

Step 4: Summarizing the evidence

This step requires data synthesis which consists of meta-analysis: “… tabulation of the features of the study, quality and effects as well as use of statistical methods for exploring differences between studies and combining their effects (Khan, et al 2003, 118). For this study, figure 1 indicates the range of years, sources, retrieved documents, annual growth, authors, among others.

Figure 1: Main Information

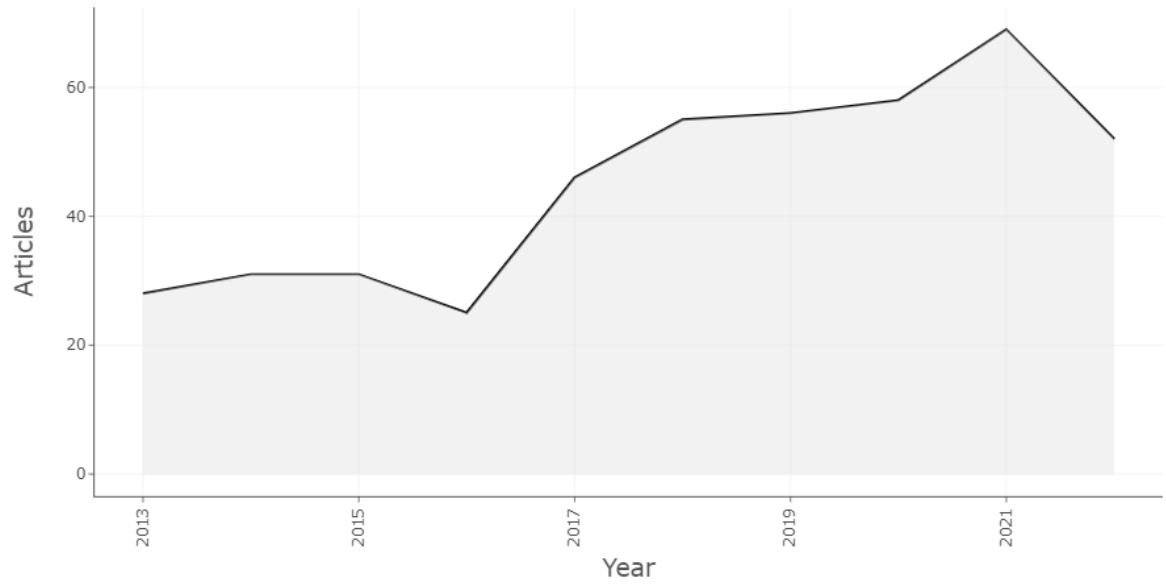

Figure 2: Annual Scientific Production

Figure 2 shows that the selected field is a trendy subject as the graph indicates an upward movement from 2013 to 2022. This suggests the need for more research in this field and this is the reason for which the authors opted to conduct this study.

Step 5: Interpreting the findings

According to Khan et al (2003), this step focuses on presenting the overall summary of the study from which inferences can be generated. Khan et al (2003) further state that "… recommendations should be graded by reference to the strengths and weaknesses of the evidence (p. 118)." In this study, the authors using the RStudio package annalysed all retrieved literature, generated themes which are as presented in figure 3 below and further discussed in the section titled "findings and discussions".

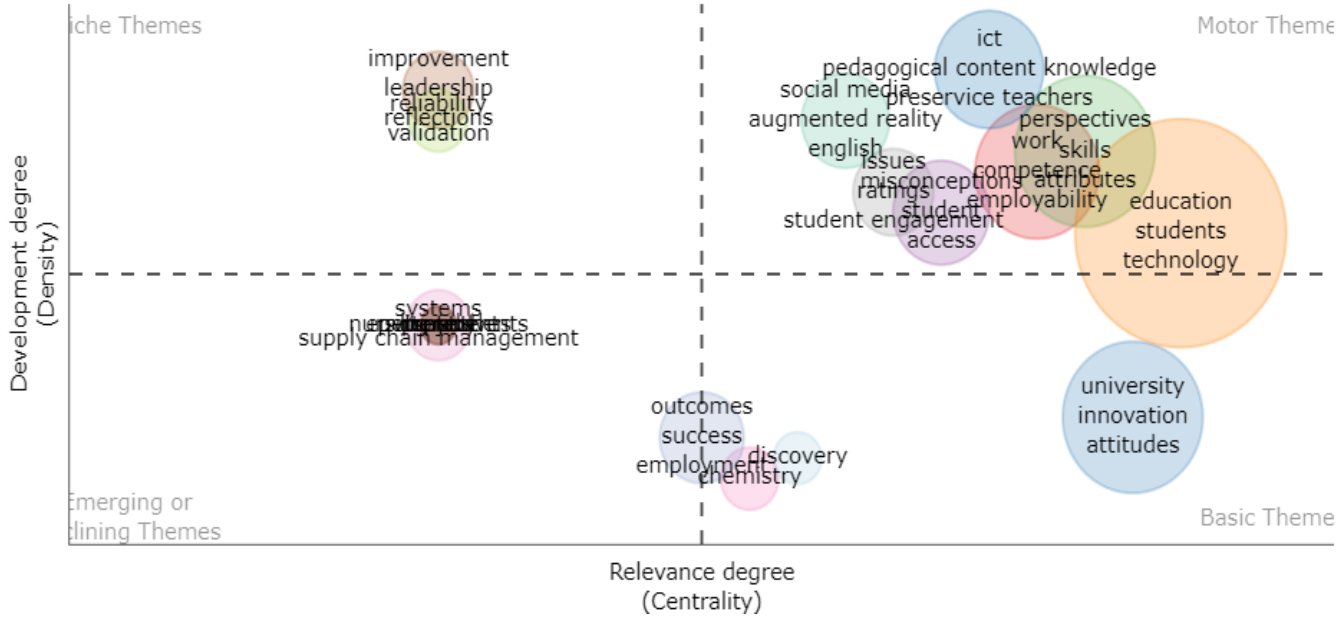

Figure 3: Thematic/Quadrant/Contextual Map

Findings and discussions

The findings of the study show that the contextual issues of teaching and learning in the context of African higher education are categorised into four broad themes known as: niche themes, motor theme, emerging or dining themes and basic theme. Each of these themes with the identified sub-themes are presented and discussed below:

Theme 1: Niche Themes

This theme is found in the upper-left quadrant. Sequel to the findings of the study, it is evident that certain niche research areas relevant to industry 4.0. have been identified. These are presented and explained below as sub-themes: improvement, leadership, reliability, reflections, and validation.

Sub-theme 1: Improvement

This theme suggests the need for improvement for institutions, organisations, entities, among others to ensure relevance. This finding corroborates the work of Brown (2021) who states that there is "*… need for relentless improvement*, however, organizations must create an innovation culture …. (par.13, italics added for emphasis)." This implies that whilst there is need for improvement, such is to be backed up by activities promoting culture of innovation. In congruence, Fox and Signé (2021) state that "…. 4IR technology brings opportunities for production cost reduction, productivity and earnings improvement, … (p. II). This suggests that in the era of industry 4.0, earnings are envisaged and speculated to improve. This is

based on a boost in the employment rate among African youths (Fox & Signé, 2021). For instance, "Improving employment opportunities in Africa is particularly salient now and will remain important given the number of young people expected to enter the job market (Fox & Signé, 2021, II)." Thus, there is need for government to "… improve business environments, …. (Fox & Signé, 2021, 4)." This indicates that improvement is expected in the earnings during the 4IR, however, this is hinged on the significant need to improve employment opportunities for young people in the African continent. Similarly, Schultz (2021) alluding to the work of DiRomualdo, El-Khoury and Girimonte (2018) emphasises the need for "…necessary changes to meet the demands of digital transformation of the enterprise and seize the opportunities to improve HR capabilities, service offerings and performance."

Sub-theme 2: Leadership

Leadership is considered crucial in the industry 4.0 as it is the process by which the enablement culture of individuals and teams are managed (Brown, 2021). Through leadership "… leaders will have to take a human approach to drive better engagement (Brown, 2021)." In support, Redflank (2021) reports that in the Fourth Industrial Revolution, leadership skills are crucial and in high demand. In addition, Fox and Signé (2021) holds the view that leadership is one of the skills knitted to entrepreneurship which is of demand in industry 4.0. Sequel to the findings of Schultz (2021), leadership is important as leaders are needed to make informed decisions which determine the success of organisations. Furthermore, Schultz (2021) citing the work of Aryati, Sudiro, Hadiwidjaja and Noermijati (2018) opines that there is need for leadership in the 4IR to be ethical, that is uphold credibility and honesty by "doing the right thing, openness of communication, a personal life based on morality standards and being fair in decision-making, which influences ethical behaviour." This suggests that whilst leadership is important, ethical leadership is to be preferred for more productivity and efficiency in the Fourth Industrial Revolution.

Sub-theme 3: Reliability

In the 4IR, "…. *the reliability of the grid and the network*, which could indirectly lead to new wage job creation and increased earnings for (household) enterprises (Fox & Signé, 2021, italics added for emphasis)." is needed. Review of the Redflank (2021) report shows that with regards to reliability, it is to be tilted in the availability of 5G network. This implies that the available technology is to be improved to a point of being reliable.

Sub-theme 4: Reflections

This theme suggests that need for a reflection on past experiences, and what can be done to ensure improvement. In this regard, the occurrences of the past revolutions can be reflected

upon in order to make provision for a better and smooth transition into the Fourth Industrial Revolution. For instance, in the case of reflection, issues regarding the curricular being aligned to enhance the practices of the 4IR, can be reflected upon and improved.

Theme 2: Motor Theme

This theme is in the upper-right quadrant (Corte, Del Gaudio, Sepe & Sciarelli, 2019; Cobo, et al 2018). Theme in the upper-right quadrant are of high centrality and density which implies that 'they are developed and are important to the research field (de Wet & de Kock, 2021).' The finding of the analysed data showed that the following subjects are developed and are important to the research field: ICT, pedagogical content knowledge, social media, preservice teachers, augmented reality, perspectives, work, skills, misconceptions, competence, student engagement, access, education, students, and technology. The identified themes are research field

Theme 3: Emerging or dining themes

This theme in the lower-left quadrant is known as emerging or dining themes. The identified emerging themes from the findings of the study as seen in the lower-left quadrant are systems, and supply chain management. The finding on systems being an emerging theme of the 4IR corroborates the works of scholars such as Bhagwan and Evans (2022), Fanoro, Božanić and Sinha (2021), as well as Philbeck and Davis (2019) which considers 4IR as being synonymous to systems by stating that the revolution. Thus, systems in the era are qualified as smart and are expected to ensure a good blend of both organizations and people with technologies. Conversely, according to Galati and Bigliardi (2019, 10), the four overarching emerging themes of industry 4.0. are technological solutions, operations, business, as well as work and skills. This is in congruence with the submission from the review of the work of Schwab (2016a) which shows that technology, skills, and business especially in relation to technology have crucial roles to play in Industry 4.0. This implies that the need to explore subjects around systems, and supply chain management especially in relation to technology and its demand is crucial in the Fourth Industrial Revolution (4IR).

Theme 4: Basic theme

This theme is found in the lower-right quadrant. It is described as basic and comprise of the following: university, innovation, attitudes, discovery, and chemistry. This finding corroborates the work of scholars who hold the view that universities (Ogunlela & Robertson, 2021; Penprase, 2018), and attitudes of people (Mayer & Oosthuizen, 2021; Oosthuizen & Mayer, 2019), play pivotal role in the Fourth Industrial Revolution. For instance, with regards to innovation, Schwab (2016a) states that "… *innovation* will also lead to a supply-side miracle,

with long-term gains in efficiency and productivity (par. 7, italics added for emphasis). Meanwhile, review show that discovery is a major tenet of such era (Sihlongonyane, Ndabeni & Ntuli, 2020; World Economic Forum, 2019), as well as chemistry (Cayuela, 2021; Noble, 2020; Muderawan, 2018). Suffice to state that in the 4IR, tertiary institutions of learning such as universities have major roles to perform in supporting innovations and assisting to ensure that individuals put up the required positive attitudes capable of enabling them achieve in the desired results in Industry 4.0. This is envisaged to promote discoveries. Meanwhile, a course like chemistry is considered crucial to enable the promotion of activities of Industry 4.0, thus, is to be treated accordingly.

Theme 5: Overlap between emerging or dining and basic themes

Findings of the study from the quadrant show that certain contextual issues in teaching and learning in African tertiary education in the 4IR overlap between two quadrants: the lower-right and lower-left. The subjects are: outcomes, success, and employment. The finding on outcomes being a major subject to be treated with concern coincides with the submission of Schwab (2016b) who states that "… *it is important that we pay attention to how we can ensure* … advances continue to be made and *directed towards the best possible outcomes* (p.26)." This suggests that a shift in the outcomes is expected to be tilted towards ensuring reduction in operational costs and improvement in customer engagement. With regards to success, Schwab holds the view that the way and manner by which such is to be measured in the 4IR may differ from previous occurrences. Schwab (2016b) submits that "… new ways of measuring and rewarding performance, new strategies for attracting and retaining skilled talent will all become key for organizational success (p. 60)." This indicates and suggests a change in the measurement of success. Moreover, the occurrence of change in different spheres of human endeavours is expected to affect the measurement of success. Similarly, employment is considered critical. Schwab (2016b) holds the view that the shift is expected to have positive impact in employment by combating unemployment by creating more jobs. In congruence, Nath (2018) states that the "Fourth Industrial Revolution emphasizes self-employment." On the other hand, following the findings of the works Frank et al (2019), Brynjolfsson, Rock and Syverson (2017), Mitchell and Brynjolfsson (2017), globally, Automation and Artificial Intelligence are bound to have huge effect on employment. The foregoing suggests the areas in which increased employment is envisaged.

Conclusion

The study using a systematic review explored the contextual issues in relation to teaching and learning in African higher education in Industry 4.0. Different themes were identified in

four quadrants. The findings from the above identified themes are as presented in figures 3 and 4 respectively using a word cloud.

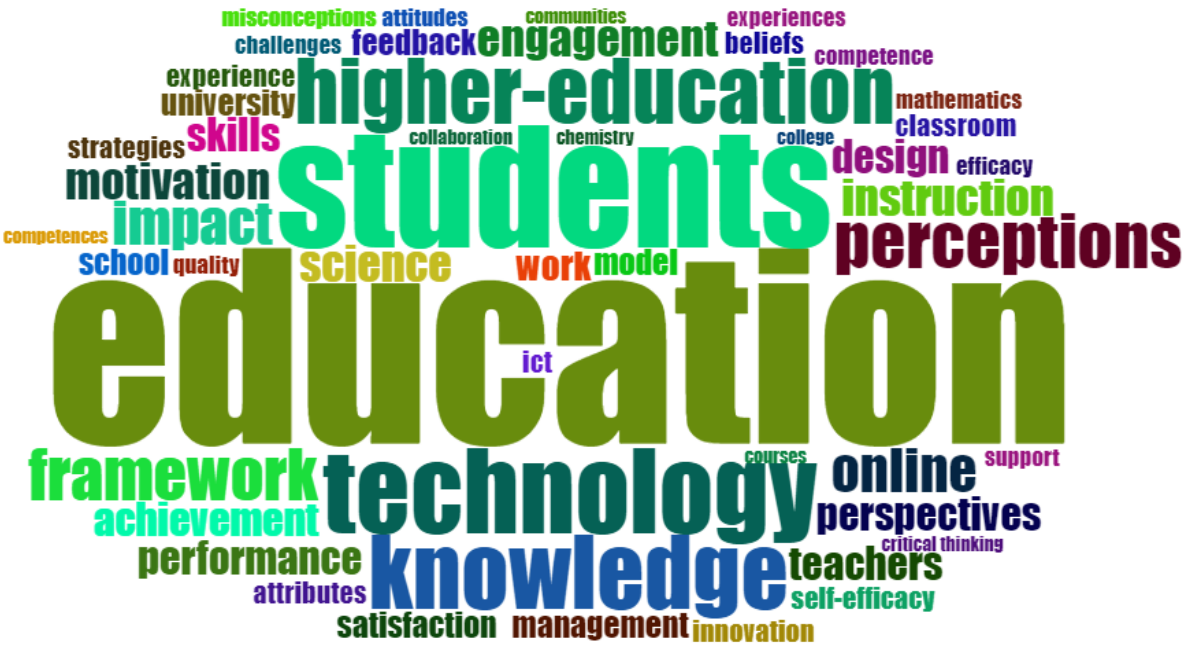

Figure 1: Word Cloud

Figure 3 at a glance shows the different identified contextual issues in teaching and learning in the Fourth Industrial Revolution era as it concerns tertiary education in the African continent. Figure 3 shows that education, students, technology, knowledge, among others are major subjects worth investigating with regards to African higher education in the Fourth Industrial Revolution.

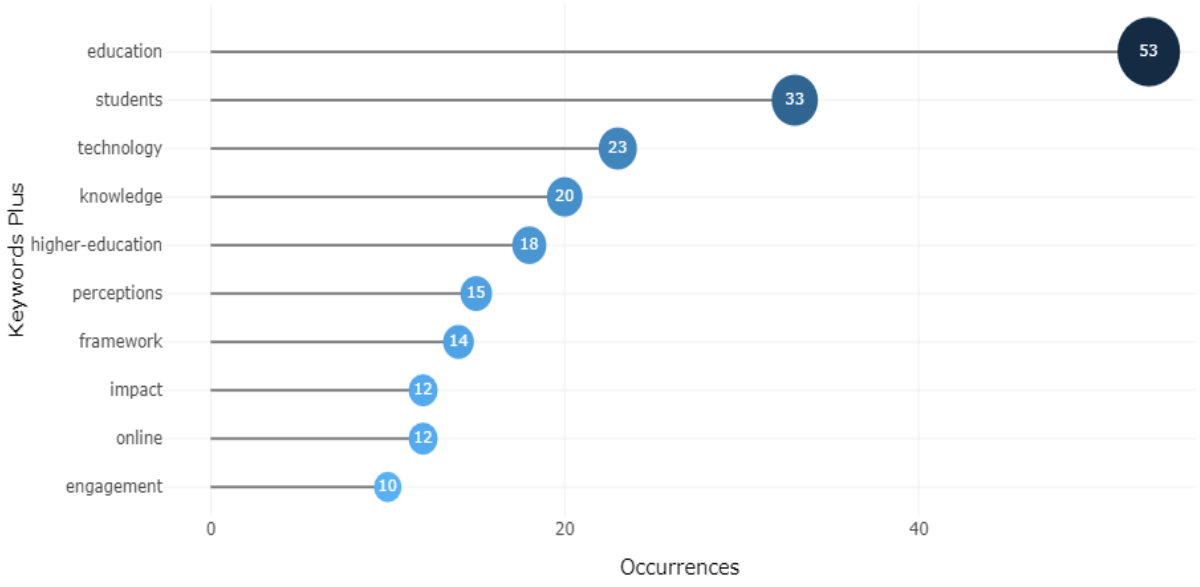

Figure 2: Word Cloud description

Figure 4 indicates the extent to which each item is considered important. For instance, while engagement is considered the most limited with 10%, education emerges the highest with 53%. This is above the report for students (38%), technology (23%), among others. This suggests that the subject of education in the context of teaching and learning in African higher education in the 4IR is considered more paramount compared to technology and other identified factors. This finding confirms the quest for the Sustainable Development Goal (SDG) 4 by the United Nations which is ensuring the promotion of inclusive and equitable quality education as well as lifelong learning opportunities for everyone (Education2030UN, n.d). Following the findings of the study, especially to ensure sustainability, it is recommended that:

- African higher education should be supported by education stakeholders to ensure that they are inclined and position for relevance following the demands of industry 4.0. This can be done by aligning the curricular of African high institutions of learning to cater for the four identified themes in the quadrants. In this regard, African higher institutions of learning would be able to promote and enjoy sustainable development in the continent.

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