



The use of technology in higher education: Implications of the Fourth Industrial Revolution

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Abstract: This study examines the implications of the Fourth Industrial Revolution (4IR) on the use of technology in higher education. With the increasing integration of technology into all aspects of society, higher education institutions are facing new opportunities and challenges. This study utilises a qualitative research design, analysing existing literature on the use of technology in higher education and the impact of 4IR. The findings suggest that the use of technology in higher education has significant implications for teaching and learning, including the need for new pedagogical approaches and the development of new skills for both educators and learners. Additionally, the study identifies several challenges associated with the use of technology in higher education, including issues related to privacy, security, and the digital divide. The study concludes that institutions of higher education must be proactive in adapting to the changes brought about by 4IR, developing strategies and policies that promote the effective and responsible use of technology in teaching and learning. The implications of 4IR on the use of technology in higher education are significant, and institutions must take action to ensure that they are able to meet the needs of learners and prepare them for the challenges of the digital age.

Key words: Fourth Industrial Revolution; Technology; Higher education institution; Online learning; South Africa

1 Introduction

A confluence of digital technologies brought about by the Fourth Industrial Revolution (4IR) is changing industries, including higher education institutions. When it comes to the adoption of technology in higher education to stay up with, South Africa is in the forefront of the African continent. Nevertheless, it is also important to note that South Africa has low technological capability, plummeting economic complexity and a fall in digital technological readiness [1]. It is further stated that there is also a dearth of skilled workforce and technological infrastructure [1].

Higher education has undergone significant change as a result of the 4IR, which has unleashed an unparalleled flood of technical advancements. Technology is being used more and more in educational institutions to transform teaching and learning

strategies, student involvement, and operational procedures. According to literature, in the South African higher education context, institutions are embracing these technological advancements to enhance the learning experience and better prepare students for a dynamic future [2,3].

The use of technology in higher education in the South African context has the potential to improve educational performance and address various challenges. This research article examines the current state of technology adoption in South African higher education institutions, analyses the implications of 4IR technologies on teaching and learning, explores the changing role of academics, and discusses the opportunities and challenges faced by South African universities in embracing the digital transformation.

2 Material and methods

The article used secondary data from scientific articles. Therefore, this article uses qualitative approach. It uses a desktop method to argue how 4IR have affected higher education landscape in terms of teaching and learning in the South African context.

3 Results and discussion

3.1 Technological advancements in higher education

The global pandemic (COVID -19), which affected and disrupted all facets of the global economy in the year 2020, brought the reality of the 4IR to light [4]. Higher education institutions were forced to embrace the 4IR. Thus, in the South African higher education, technological advancement was presented because the use of technology in higher education was promoted. Although the higher education system in South Africa has seen some change, it is still not equipped with the knowledge and abilities needed for the digital society of the twenty-first century. According to Kanyane [5], “the critical skills to be in possession by an academic staff required here in the digital education space include business intelligence, digital transformation, cybersecurity, and cloud computing to transform the education landscape at work by consistently and constantly influencing learning, teaching and research applications”. The discussion below presents changes brought by the use of technology in higher education institutions, and these changes require a new set of skills.

Online Learning and Massive Open Online Courses. The rise of online learning platforms and Massive Open Online Courses has fundamentally transformed access to education in the South African higher education landscape. It is important to highlight that before digital age, online learning platform was highly promoted by University of South Africa through its distance learning approach. Online learning offers flexibility and convenience, enabling learners to access quality education regardless of geographical barriers [6]. In other countries, Massive Open Online Courses have wit-

nessed tremendous growth, with millions of learners enrolling in diverse courses from prestigious universities [7]. In South Africa, Massive Open Online Courses is now being promoted. These advancements have implications for higher education institutions, as they need to adapt their offerings to cater to a global audience and enhance their online pedagogical strategies [8].

There are challenges that comes with the use of online platform as a mode of teaching and learning, particularly in South Africa. For example, poor access to online materials, uncertainty regarding how to study via this mode, and the discomfort of spending extensive periods at the computer can be a barrier when using online platform as a mode of teaching and learning [9]. Load shedding can also affect network coverage taking into consideration South African power crises.

Virtual and Augmented Reality. Virtual and augmented reality technologies have opened new frontiers in immersive learning experiences. Institutions of higher learning are exploring the potential of these technologies to facilitate experiential learning across various disciplines [10]. Virtual reality enables simulations and field trips, offering students realistic and practical scenarios for better comprehension which can be useful in the world of work. It is asserted that augmented reality enhances learning by overlaying digital content onto the physical world, transforming traditional teaching approaches [11].

Artificial Intelligence and Machine Learning. Artificial Intelligence (AI) and Machine Learning (ML) have revolutionised the higher education landscape, introducing personalised learning pathways and intelligent in teaching and learning. However, besides the use of Chat Gpt, there is limited data on the use of AI in the South African higher education. Chukwuere [12] alluded that “Chat GPT is a technological solution with the potential to cause significant interference, disruptions, and modification in the higher education sector, by affording customisable and individualised learning with instant feedback, elevating accessibility, and amplifying student interactions”. According to a recent report from Educause, an organisation dedicated to supporting the use of technology in tertiary education, Chat GPT could potentially have a revolutionary impact as a "game changer" or disrupter, leading to a significant transformation in both the pedagogical methods used by teachers and the learning methodologies of students [13]. However, the utilisation of Chat GPT in higher education gives rise to numerous ethical and privacy quandaries, among which are the compilation, academic dishonesty and handling of student information [12]. These technologies analyse individual learning patterns, strengths, and weaknesses to tailor educational content, pacing, and assessment [8]. AI-driven chatbots should also be deployed to provide instant support to students, enhancing their learning experiences [14], particularly in South Africa.

Internet of Things and Smart Campuses. The integration of Internet of Things (IoT) devices in higher education has led to the emergence of smart campuses. IoT is

expanding swiftly and becoming a global phenomenon that inspires both enthusiasm and concern [15]). IoT sensors and devices collect vast amounts of data to optimize campus infrastructure, automate administrative tasks, and enhance security [16]. It is emphasised that “with the support of IoT, institutions can enhance learning outcomes by providing more affluent learning experiences, improved operational efficiency, and by gaining real-time, actionable insight into student performance” [17]. Smart campuses streamline resource allocation and improve the overall campus experience for students and faculty members. IoT is not only used for online teaching and learning but also in administration and registration. Over the years, higher learning institutions in South Africa have been moving from the traditional ways of students’ applications and registration to online system [17]. Nevertheless, there is limited information on the system that these institutions have adopted.

3.2 Changing role of academics

Due to the effects of technological advancement, new managerialism, and global competitiveness, the higher education industry has seen substantial changes [18]. These developments are expected to have an impact on the perceived roles of academics. Thus, the traditional role academics as it is known can be influenced by the current technological advancements, requiring academics to implement various ways to successfully cope with the changes.

Technological Literacy and Professional Development. As technology integration becomes more ubiquitous in the academic environment, technological literacy is a crucial ability for academics in higher education. Since the 4IR is reshaping higher education, academics need to be knowledgeable and skilled in using technology to improve teaching and learning. Therefore, as technology becomes ubiquitous in higher education, academics must develop technological literacy to effectively integrate digital tools into their teaching methods. Professional development programs and workshops can play a crucial role in equipping academics with the necessary skills and confidence to navigate the digital landscape [19].

Furthermore, with technology becoming an integral part of the modern era, academics with high levels of technological literacy can create innovative and engaging learning experiences for modern day students. For example, academics can incorporate multimedia elements in lectures, design interactive online courses, and facilitate personalised learning pathways through adaptive educational technologies [20]. Furthermore, Kenny and Zhang [21] claim that technologically literate academics can effectively utilise educational data to assess student progress, identify learning gaps and tailor instructional approaches to meet individual student needs.

The ability to teach students the digital skills they need to succeed in the workforce of the twenty-first century is another benefit of technological literacy for academics. Academics may equip students to be digitally literate and adaptive in a technological environment that is always changing by integrating technology into their teaching methods [22]. Thus, the technological advancement may require academics to move out of their comfort zone to learning new approaches that have been brought by tech-

nological advancement. Thus, in order to remain relevant and motivated, academics are faced with a challenge of acknowledged the fact that times have changed and teaching as they know it have also changed.

Shifting from "Sage on the Stage" to "Guide on the Side". In the traditional teaching style, often known as the "Sage on the Stage," the teacher assumes a prominent and authoritative position in the classroom while giving lectures and imparting knowledge to students. But with the rise of contemporary educational ideas and the integration of technology into the learning process, there has been a paradigm change in favour of the "Guide on the Side" strategy [23]. In other words, this method highlights the shift in the instructor's position from one of authority to one of facilitator, assisting students in engaging in active and self-directed learning. The traditional "sage on the stage" model, where educators play a dominant role in lecturing, is transitioning towards a more student-centred approach. Academics now act as facilitators, guiding students through their learning journeys and encouraging active participation and critical thinking [10].

3.3 Challenges and opportunities for institutions

Teaching and learning in South Africa may be revolutionised by the use of technology in higher education. Technology presents difficulties and possibilities for higher education institutions as the nation works to adapt to the demands of the 4IR. Thus, technological advancement presents both challenges and opportunities for institutions of higher learning and South Africa.

Digital Divide and Accessibility. The current digital gap in South Africa is one of the biggest problems. It is emphasised that for all students, especially those from rural and impoverished regions, unequal access to technology and the internet limits opportunities [24]. Thus, the smooth integration of technology in all higher education institutions is hampered by the absence of adequate infrastructure and dependable connectivity. Despite the promise of technology in education, the digital divide remains a significant challenge [25]. Therefore, ensuring equitable access to technology and digital resources is crucial for promoting inclusive education.

Data Security and Privacy Concerns. Data security and privacy are becoming major problems for institutions all over the world due to the growing use of technology and digital systems in higher education. Large volumes of private data, including student records, financial information, and research data, are gathered and processed by higher education institutions. Thus, the extensive use of technology in higher education raises concerns about data security and student privacy. As a result, it is suggested that institutions must implement robust data protection measures to safeguard sensitive information [26]. Institutions of higher learning handle a wide range of sensitive data such as students' academic records and institutional information such as financial

records. Therefore, ensuring data security is vital to protect sensitive information from unauthorized access and use [27].

Redefining Pedagogical Approaches. Technological advancement has a significant impact on pedagogical approaches in higher education. As technology evolves and new educational theories must emerge, institutions of higher learning education should re-evaluate their pedagogical approaches to better meet the needs of today's learners in the current digital era. As a result of technological advancement, traditional lecture-based teaching methods are gradually giving way to more student-centred and innovative approaches. In this digital era, student-centred approaches promote active learning, fostering higher levels of engagement and motivation among students [28]. Thus, integrating technology into higher education requires institutions to reassess pedagogical approaches. According to Warschauer [16], higher education institutions and academics need enough support and resources to effectively incorporate technology into their teaching methods. Thus, significant funding should be provided to higher education institutions to ensure that academics align with required pedagogical approaches.

3.4 Current state of technology adoption in South African higher education

Since the emergence of the COVID-19 pandemic, most Higher Education Institutions (HEIs) in South Africa moved teaching and learning to online [29]. Thus, they were forced to embrace and promote the use of 4IR technology. There is digital strategy framework [30] of the South African government, which focuses on building digital awareness through funding, research, and coordination aimed at improving the quality of education and economic growth through enhanced digital skills [29]. Thus, for the framework on digital strategy to be successful, funding to assist to build digital skills is needed. Digital transformation in higher education requires financing and a great investment [31]. It is important to note that over the years, the budget for public Higher Education has been declining and a lot of universities are now struggling to embrace the digital age [32]. Therefore, it can be difficult, if not impossible, for institutions of higher learning to take advantage of technological advancement. Without adequate funding, academics will not be privileged enough to the possibilities that are presented by technology.

The academic staff of the twenty-first century ought to be fortunate and wealthy to be living in a digital world and working at a period of intense educational change and adaptation. The usage of chalkboards, chalk, and discussion has been replaced by an online presence or a combination of both (hybrid), replacing physical touch [5]. It is important to acknowledge that digital technologies openly advanced access to education and how academic staff and students could virtually connect and transmit knowledge irrespective of their geographical spaces and time zones. Thus, according to Masenya [33], “the use of these technologies in the classroom should be seen as complementing the academic staff’s role in teaching and learning.

E-Learning and Online Platforms. South African universities have embraced e-learning and online platforms to expand access to education and accommodate diverse student populations [34]. Both academics and students must fast adjust to the shift to online learning (E-Learning) from the conventional method of teaching and learning in order to remain relevant and current. Nevertheless, it is crucial to remember that completely online learning offerings date back to the early 1980s [35]. However, this article argues that most South African institutions of higher education, with exemption of University of South Africa, did not fully support this type of teaching and learning strategy, which is why it can be seen as it is in a development stage [36]. In other words, online education in South Africa is still in its infancy.

Virtual learning environments and Learning Management Systems (LMS) have become integral part to course delivery, fostering flexibility and inclusivity. Despite this innovation, the South African higher education environment remained uneven for a very long time. Yende [3] claims that this imbalance may be attributed to apartheid education, out of the twenty-six public universities, some are historically disadvantaged while others are historically advantaged. There are also conservative and liberal universities.

The distinction between historically white universities (such as the University of Cape Town, University of Johannesburg, University of Pretoria, Rhodes University, University of the Witwatersrand and Stellenbosch University), and historically black universities (such as the Sefako Makgatho Health Science University, University of Zululand, University of North-West, University of Limpopo, University of Venda, University of the Western Cape, Walter Sisulu University, University of Fort Hare, among others) was arbitrary [3]. The educational quality of learning was damaged by their structural categorisation of these universities. For example, according Kanyane [5], most rural-based institutions experience poor network connectivity, which can dismally disrupt digital work and learning.

Mobile Learning. The widespread availability of mobile devices has enabled mobile learning initiatives in South African higher education. Mobile technologies offer opportunities for personalised learning, improved engagement, and anytime, anywhere access to educational resources [24]. However, lack of mobile devices for rural area students can be seen as a challenge to teaching and learning. The rural locations are home to a substantial portion of South Africa's student population. This represents the student population's dispersion in the provinces such as Limpopo, the Eastern Cape, Kwa-Zulu Natal and Mpumalanga, which are typically thought of as rural areas. The quality of teaching and learning in rural South Africa is also being compromised by a number of reasons, making it more challenging for governments to deliver high-quality educational services there [37]. Rural South Africa has historically been characterised by very high rates of unemployment and poverty, as well as by incredibly few job prospects [38]. Thus, this makes it difficult for rural area students to buy mobile gadgets.

Open Educational Resources. Over the years, open and distance (online learning) learning has been growing significantly in South Africa and continues to grow. There is also growing interest and examples of online learning, which may or may not be offered by distance education providers [39]. The author further stated that learning resources are central to both forms of provision and so it seems logical that there should be extensive interest in working with Open Educational Resources (OER). According to Pounds and Bostock [40], the use of Open Educational Resources has the potential to increase teaching efficiency, increase quality of teaching, and reduce economic and geographic barriers to teaching and learning. The main barriers to use are academic competition between institutions and educators, low awareness and availability of OERs and copyright policies, mistrust in OER quality, and technological limitations around adaptation and sharing [40]. Open Educational Resources (OER) initiatives have gained traction in South Africa, promoting the sharing of knowledge and resources among educators and students. The use of OER helps alleviate financial barriers and enhances collaboration among institutions [41].

4 Limitations of the study

The study focused on the impact of 4IR in the South African higher education. Therefore, the results may not be applicable outside South African higher education sector.

5 Conclusion and recommendation

Using the 4IR technologies, the higher education in South Africa is reshaping. The landscape of teaching and learning is changing as a result of e-learning, mobile learning, and open educational materials. In order to improve student results, educators must employ technology pedagogical strategies. While South African universities face challenges related to infrastructure and connectivity, embracing technology presents opportunities for inclusive education and collaborative research. South African higher education may transform and prosper in the digital age by utilising the 4IR technologies. In conclusion, South African higher education institutions must be proactive in adapting to the changes brought about by 4IR (technological advancement). Furthermore, they must develop policies and strategies that can promote the effective and responsible use of technology in teaching and learning. The department of higher education and training should prioritise funding to technology that must be used in higher education. Furthermore, institutions of higher learning should conduct workshops for all academics on the use of technology in their teaching pedagogy.

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