Chapter

Adoption of Educational Fourth Industrial Revolution Tools Pre and Post-COVID-19 and the Emergence of ChatGPT

Vusumuzi Maphosa and Mfowabo Maphosa

Abstract

The COVID-19 pandemic forced governments, industry, and educational institutions to deploy digital platforms to minimise disruptions in daily life. Institutions that had adopted Fourth Industrial Revolution (4IR) tools minimised learning disruptions by quickly migrating to the online environment. 4IR tools include artificial intelligence, virtual reality, robotics, intelligent tutoring and natural language processing systems. Although migrating to the online environment was challenging for most developing countries, COVID-19 offered a rare opportunity to leapfrog into a new digital trajectory. Our study considers COVID-19’s effects on education and the ethical issues arising from adopting 4IR tools and pays particular attention to the impact of ChatGPT. The results show unprecedented and accelerated adoption of 4IR tools during COVID-19 in developed countries while developing countries struggled. We highlight 4IR affordances, constraints and ethical issues. Affordances include independent learning, chatbots, virtual reality and intelligent tutoring systems. Concerns include bias, academic cheating, surveillance, data privacy, and unavailability of policies. 4IR development is private-sector-led; educational institutions and governments need to formulate policies that safeguard the integrity of education. We highlight future scope and opportunities for 4IR tools in education, current limitations and future research trends. We propose a research agenda which evaluates the impact of ChatGPT on education.

Keywords: education, adaptive and interactive learning, fourth industrial revolution, natural language processing, ChatGPT, ethics, surveillance, academic cheating

1. Introduction

Ever since the outbreak of the COVID-19 pandemic, governments, industry and educational institutions have been under pressure to deploy digital platforms to minimise disruptions to daily life. The pandemic catalysed the metamorphosis of educational delivery in developing countries which had remained stagnant through
traditional teaching methods. These could no longer serve the needs of 21st-century learners. COVID-19 resulted in the global acceptance of online learning as a substitute for in-person teaching and learning. COVID-19 forced the massification of online education in Africa, which had previously faced many implementation hurdles [1].

At the onset of the pandemic, migrating to the online environment became a stumbling block as staff and students developed negative attitudes towards acceptance, citing unfamiliarity with online instruction tools [2, 3]. Countries that had not yet embraced the fourth industrial revolution (4IR) tools for education relied on social media sites like WhatsApp and pre-recorded radio programmes for teaching and learning [4, 5]. Institutions that had embraced 4IR tools, such as AI, virtual reality, e-learning, chatbots, and augmented reality, quickly migrated to online and remote learning without teaching disruptions. Due to unfamiliarity with 4IR tools, many learning institutions in developing countries failed to conduct lessons at the pandemic’s peak as they shut their doors to the public. Other challenges with migrating to online teaching during COVID-19 included poor connectivity, lack of resources and difficulties students and lecturers face adapting to the new norm [6].

African scholars have expressed optimism that disruptions in traditional learning caused by COVID-19 will bring reformation and innovation to an education system that has long since lost relevance [7, 8]. Thus, the uptake of technology-mediated education will have a tremendous impact on the educational landscape in Africa. The transition will require a paradigm shift from content creation, lecture delivery and examination processes. Many countries have positively responded to COVID-19 disruptions by implementing broad strategies to enhance online learning adoption [4].

COVID-19 negatively impacted the global economy, resulting in reduced funding for education when learning institutions were at their most vulnerable state [9]. Institutions failed to get financing for ICT gadgets, upgrading their broadband infrastructure and training staff and students [10]. For learning institutions, moving to the online environment resulted in revenue loss as students no longer needed to use halls of residence and recreation facilities as they moved to their homes. Muftah [9] reports that academics and students in developing countries perceived online teaching and learning delivery as too difficult and abrupt, with no preparation. They required prior training and more adoption time. COVID-19 also altered the lives of undergraduate students who could not experience the extraordinary life of being on campus [11]. As the pandemic subsided, institutions gradually moved to blended and in-person learning. Parents raised optimism that COVID-19 raised the momentum to migrate to online learning and would lower tuition fees signifying a significant change in education delivery. COVID-19 offered new opportunities for research on the global adoption of educational technologies as vast amounts of data were generated from these virtual environments [12].

Despite the delays in embracing digital technologies by most developing countries, the World Economic Forum (WEF) reports that over 65% of primary school learners would pursue careers and work in new occupations that currently do not exist [13]. The 4IR is changing every aspect of the global economy through technologies such as artificial intelligence (AI) and robotics, intelligent tutoring systems (ITSs), virtual reality, blockchain and neuro-technologies [14]. COVID-19 saw the optimum use of advanced learning technologies (ALTs), which support independent and self-paced learning. ALTs include ITSs, game-based education, and extended-reality systems [15].

4IR technologies played a pivotal role in service provision across all sectors during the pandemic and have continued to do so post-pandemic. In healthcare, many AI-powered applications, such as screening patients for symptoms, were used to save
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As movements were restricted, patients relied on virtual platforms for information access, diagnosis and medical advice [16]. In education, robots and chatbots were used, with multilingual chatbots overcoming language barriers in multinational institutions [17]. Recommender systems are used in online learning to assist learners in choosing content, career paths and qualifications [18]. Chatbots are ideal in supporting learning pre and post-COVID-19 as they facilitate interpersonal communication by responding to user questions in a natural language. Robots were also deployed at airports and public areas to detect infected people and curb the spread of the virus. In public libraries and hospitals, robots were used to disinfect books and contaminated sites [19].

Educational institutions use 4IR tools to automate administrative and repetitive tasks while deploying robots, chatbots and intelligent tutoring systems to improve teaching and learning [20]. Instructors use AI tools for repetitive and time-intensive tasks while being freed from these mundane tasks to work on higher-value tasks which require judgement [21]. AI applications can improve student recruitment and retention to increase throughput rates in specialised fields such as engineering [22].

Although 4IR tools are transformational, African countries face challenges such as limited infrastructure, cost of data and a lack of access to devices. The World Bank reports that only a quarter of the African population has access to the Internet [23]. Only a fifth (18%) of learners in Sub-Saharan Africa have access to the Internet, and a tenth to a household computer [24]. A tenth (11%) of the Sub-Saharan African countries effectively migrated into online learning, while 23% adopted broadcast radio and online learning [4]. COVID-19 stretched African universities as they attempted to migrate to online learning platforms amid challenges such as a lack of gadgets and digital skills, resistance, and high Internet costs [9]. Bryson and Andres [12] contended that learning outcomes could be undermined if the classroom learning experience was replicated online without pedagogical adjustments and the acquisition of new skills and tools. The transition to online learning during COVID-19 was abrupt, with no training for teachers and students, especially in developing countries [4, 25].

2. Concerns with 4IR tools

Although the transformative power of 4IR tools in education is undeniable, AI is adopted with anxiety and caution, considering its possible harmful effects on learners and teachers. To effectively adopt and take full advantage of AI’s affordances, regulations that promote its ethical use should be developed to address constraints and stakeholder concerns. AI works on trained data; if such data has biases, it may perpetuate inequalities; thus, policies and regulatory frameworks are required to ensure that the potential of AI is harnessed ethically. Societal biases or unethical behaviour are reflected in the decisions made by AI systems since they rely on data and algorithms to make choices and decisions. Prominent issues related to the adoption of AI in education include ethics, data privacy, widening access to education, diminished integrity and suppressing its positive impact. Ghallab [26] notes that few studies focus on the inherent risks of AI development. There is a need to highlight ethical pitfalls and map a way to safeguard users of AI systems. Our chapter contributes literature on the growth of 4IR tools in education pre and post-COVID-19 and highlights emerging ethical issues and the rise of ChaptGPT. The chapter has already highlighted the impact of COVID-19 on education, the growth and the adoption of 4IR tools in education. The remaining sections highlight the following.
• The emergence of ChatGPT.

• Ethical and societal concerns resulting from the adoption of 4IR.

• Concerns with the rise and use of ChatGPT in education.

2.1 Emergence of ChatGPT

Natural language processing (NLP) algorithms such as ChatGPT are powerful tools for supporting individual and personalised learning, language translation, and interactive and adaptive learning [27]. ChatGPT stimulates positive learning experiences by providing real-time interaction and communication by providing information and instantly answering questions using a natural language. Supervised and reinforcement techniques were used to build ChatGPT, extending OpenAI’s GPT-3 with a knowledge base built in 2021 [28]. Text generators such as the Generative Pre-trained Transformer-3 (GPT-3) can go through billions of sources when constructing text [29], making it appear original. ChatGPT is one of the most innovative and powerful technologies transforming education pre and post-COVID-19 as it interacts with users in human form. ChatGPT is highly intuitive and can write essays, academic papers, programming code and stories for students and the public. Some educators are thrilled by the potential of ChatGPT, while others have described its introduction as the death of essay writing [28].

ChatGPT supports self-paced learning, and those training for a skill get direct responses from the system [30]. It is ideal for students learning programming languages as they can get immediate and direct answers and, through examples, improve their skills and performance [31]. ChatGPT makes it easy to administer a multi-language class where learners may respond using their natural language. ChatGPT supports learning scaffolding, where the application can detect the student’s knowledge level and adjust the difficulty of questions, allowing the student to progress in their education [27]. ChatGPT aids interactive learning by creating virtual tutors through an interactive agent that understands the learner’s questions and provides appropriate responses to guide them [32]. Students can also ask questions in any subject and receive instant responses with precise feedback, thus no waiting times.

Restrictions to in-person learning during the pandemic saw examinations being taken online. There are fears that ChatGPT will compromise online evaluation as students can use ChatGPT without detection and earn higher marks. In a final MBA examination, ChatGPT produced quality responses that were better than those of students and could have earned a lower distinction (B-grade) [33]. Stock [34] laments that some text generated by ChatGPT can be attributable to the student as anti-plagiarism software still fails to detect differences between text generated by ChatGPT and human beings. Using ChatGPT will stifle creativity and critical thinking as learners increasingly depend on the chatbot. The responses from ChatGPT may not always be appropriate and accurate. As such tools enter the classroom, educators, policymakers, and governments must craft policies to guide teachers and learners to ensure responsible use. Educators need to acknowledge the affordances and constraints brought by ChatGPT and collectively work on minimising potential risks. Free accessibility of such tools cannot be guaranteed long-term once they have gained public acceptance [28]. Access to these systems is becoming subscription-based, further widening the technology divide between the Global North and the Global South.
2.2 Ethical issues

Personal identifying information is being collected at a large scale by 4IR tools pre and post-COVID-19, thus raising several ethical questions. Most public institutions do not have adequate policies to cover the increased use of digital platforms. COVID-19 has magnified our dependence on 4IR tools [35], raising security, ethical and human rights concerns arising from data breaches and undesirable outcomes.

Research shows that students have expressed anxious feelings when learning using 4IR tools when they perceive that most of their preferred careers are being made obsolete [36]. The working models produced by AI to guide learners do not explain how they arrived at particular decisions, and learners have no knowledge or skills to analyse such findings [37]. There is evidence of AI discriminating against minority groups [38], making life-threatening decisions in controversial ways, and fears of humanity being overtaken by AI [39]. To embrace AI for practical use in education, the research community must constantly assess the potential threats and vulnerabilities and develop regulatory frameworks and policies that ensure the ethical use of AI. AI-driven online learning lacks human and social aspects; learners may prefer interacting with human teachers [40]. As more learners move to AI-mediated online environments, teachers raise concerns about the lack of learning control and the failure to account for all the students. The unavailability of high-speed broadband networks in developing countries and the lack of financial resources to pay subscription fees means the knowledge and technology divide between the Global North and the Global South will widen.

2.3 Data privacy

One ethical quandary that arises with the development of AI is the large-scale collection, processing and sharing of personal information. Hongli [40] notes that varying amounts of learners’ data can be easily leaked. Data leaks outside learning institutions may result in privacy violations, where personal data is used to identify individuals who may be unfairly or maliciously targeted. Students’ data and educational records store highly sensitive information, and security measures must be in place to protect these records [41]. There are fears that the interests of teachers and learners are not adequately protected throughout the AI life cycle and can be easily violated. Some argue that learners must know with whom their data is being shared and be informed on how this will benefit them [42]. To ensure fairness, data subjects should be aware of the types of data collection and security methods whenever their data is collected [43]. Thus students must consent when their data is collected, know how it will be analysed and how it will assist them.

2.4 Policy

Most AI developments across the globe are private sector-led, with companies such as Pearson, IBM, McGraw-Hill, Dreambox and Coursera leading in adopting big data for personalised learning [44]. Some countries have designed policies that create synergies with educational technology companies to create innovation hubs and support the development of innovative teaching practices that contribute to evidence-based policy formulation. Most governments in developing countries struggle to enact policies to keep pace with the continuous advancements of 4IR tools for the education sector. Countries should partner with industry and academia to create AI programmes
aligned with their educational needs and improve educational systems. Thus education systems have to quickly produce workers with appropriate skills to build AI systems for the betterment of humanity. AI works in a complex ecosystem that developing countries should begin to nurture to avoid being further left behind; it includes regulation, knowledge management, innovations and business development [45].

2.5 Surveillance

AI-enabled systems are being applied in educational surveillance, raising ethical questions. The Chinese use intelligent classroom management systems to monitor learner participation and responses through facial recognition [37]. Teachers monitor student behaviour through computer dashboards to enhance instructional decision-making and scaffolding [15]. The use of dashboards for student monitoring and surveillance raises ethical questions. AI applications for curtailing academic fraud have been described as intrusive, such as using drones, webcams and keystroke detectors during examinations [46]. AI-based predictive systems have embedded surveillance techniques to predict student performance, weaknesses, strengths, learning patterns and the possibility of dropping out.

Although part of the teacher’s duties involves monitoring student progress, it raises ethical questions and possibilities of cybercrimes such as bullying, stalking and exposure to sexual content when done online [47]. This threatens the learner’s privacy. Students do not feel secure and confident if they know their educational activities are under surveillance from AI-based systems. In examination-based proctoring systems, students may feel unease by being continuously monitored, which can affect their mental health and cause them to underperform in their examinations [48]. Akgun and Greenhow [47] note that students may be apprehensive and not participate in online conversations if they know they are under surveillance. This often makes them feel unsafe and uncomfortable taking ownership of their ideas. There is great danger that educational data may find itself in the hands of law enforcement agents who may use it for surveillance.

2.6 Academic cheating

Academic cheating has long existed before, where one writes a paper for another person for a charge [49]. Still, these techniques are diminishing, as AI-based article generation is free. The rise of online learning and the commodification of education has increased cheating. ChatGPT generates assignments or essays per the teacher’s guidelines and observes grammar and syntax, making it difficult to distinguish between the machine’s work and the learner’s. Text generators are used to produce research and thesis papers, which is academic fraud. Brown et al. [50] contended that these systems produce text that is difficult to detect that it was not written by a human being, thus promoting academic dishonesty. There are worries that ChatGPT is democratising plagiarism by offering free ghostwriting services for students and the public [34]. AI text generators instantly generate academic work for learners, opening loopholes for academic cheating [31], where the learner’s competency and aptitude cannot be evaluated. Only 63% of abstracts created by ChatGPT were discovered to be fake and machine-generated; worryingly, more AI-generated text will find itself in journals and literature repositories [51]. Abd-Elaal et al. [52] conducted a study to test whether current anti-plagiarism tools could detect text generated by AI; results show that text detectors failed to detect such text. It attributed this text to a human writer.
2.7 Biases from natural language processing systems

NLP systems can reinforce stereotypes and perpetuate gender biases. Such systems may associate a doctor with a “he”, a nurse with a “she”, a homemaker with a woman and a programmer with a man [26]. At the same time, ChatGPT is a powerful tool that can improve language literacy, grammar and spelling, and communication, especially for learners who are not native English speakers [27]. Users of the system must not over-rely on ChatGPT and must verify if the information is accurate and valid, as the system depends on the data it was trained on. Some biases may be related to language and culture, especially the dominance of English and Western cultures. NLP applications like ChatGPT have the potential to perpetuate some inequalities related to access to technology, especially in developing countries with limited access to infrastructure and stable financial services systems which can facilitate subscription payments.

3. Discussion

Although COVID-19 created problems for education, on the flip side, it offered undeniable opportunities for innovation and the adoption of digital tools to support a new dawn. Ratten [53] postulated that COVID-19 pushed institutions that relied on traditional forms of learning into the digital world. The global adoption of digital technologies allows everyone in the online learning technology value chain to address some emerging challenges innovatively. However, with continued disruptions to face-to-face meetings, many African learning institutions had no option but to adopt some form of technology-mediated teaching and learning. For developing countries, COVID-19 presented a once-off opportunity for learning institutions to embrace 4IR tools that support education during the crisis and transform educational delivery. This also allowed governments to assess their technology and regulatory deficiencies in supporting deploying 4IR tools for remote-based learning. These tools ensure that learning and teaching occur regardless of physical, space, distance and time limitations pre and post-COVID-19, as returning to the traditional learning model is no longer tenable. Teachers and learners will thus develop skills required for the knowledge economy as they use 4IR tools to support online learning.

The development of 4IR tools for education should be achieved through collaborative research through partnerships with learning and research institutions. Teachers and school administrators use AI-driven monitoring and surveillance systems to improve learning, but these raise ethical questions. NLP systems are redefining learning by supporting individual and personalised education, language translation, and interactive and adaptive learning, ideal during learning disruptions caused by pandemics such as COVID-19. Their use in education may perpetuate and reinforce biases against gender and minority groups.

NLP tools such as ChatGPT rely on content from algorithms that may be trained based on certain biases and stereotypes. Without policies, teachers are unlikely to detect the difference between machine-generated and human-constructed text. These systems are built using AI with the capacity to circumvent plagiarism tools. Eventually, students will develop skills to further evade plagiarism detection on material generated by ChatGPT, such as changing keywords and phrases. Although the disruptive effect of ChatGPT has come to the fore, educational institutions in developing countries are yet to consider adopting it, enact policies that support its use and address challenges such as academic dishonesty.
4. Conclusion

The COVID-19 pandemic has been transformational, forcing many institutions to reform and embrace 4IR tools to remain operational. This has led to the massive adoption of 4IR tools pre and post-pandemic as institutions try to stay operational and minimise disruptions. Although most developing countries have infrastructural challenges, the outbreak of COVID-19 forced learning institutions to adopt 4IR tools such as online learning, virtual reality and intelligent learning systems to sustain teaching and learning after in-person learning was banned. This trend has continued past the pandemic as returning to the traditional education delivery system is no longer feasible. As students migrate to the online environment due to COVID-19, parents, governments, and other stakeholders have raised optimism that it will widen access to education as tuition fees reduce and online services are relatively cheaper. AI is slowly replacing varying aspects of the teacher’s job, and retraining of teachers is needed.

Adopting 4IR tools allows institutions to collect, process and store vast amounts of data for modelling AI-driven systems. The accountable and transparent use of algorithms in decision-making in the education sector should involve students. Student data must be safeguarded through policies to minimise abuse once it falls into the hands of the wrong people. The use of NLP systems is a welcome development. However, it raises concerns about academic fraud as techniques such as ChatGPT can write assignments, research papers and theses for students while adhering to grammar and syntax. Although these systems can improve learner outcomes, they are prone to abuse and require policy and regulation. As such, these systems are challenging to detect, and governments and educational institutions should speed up educational reforms and enact policies to protect the integrity of the education sector.

Most 4IR projects are private-sector initiated and led, and governments should create an environment that supports public-private partnerships for project-based collaborations to tap into the expertise of the private sector. The developed world should partner with and support developing countries in adopting 4IR tools to mitigate the effects of the COVID-19 crisis and for the progress of the education sector. Governments should accelerate the implementation of 4IR-powered technologies such as virtual and augmented reality, blockchain, and intelligent tutoring systems for the growth and future resilience of the education sector amid disruptions. The effect and impact of 4IR tools remain uncertain; therefore, more research is required to drive policy formulation and protect the teachers, learners and the public. We contribute to scholarship by raising ethical questions and initiating debates that stimulate stakeholders to interrogate these issues and find solutions. Scholars should further evaluate the impact of 4IR tools, particularly the emerging ChatGPT, which is disrupting the current state of education. The adoption of such tools by educational institutions is already raising debate, and this will assist in guiding future 4IR projects, especially in developing countries that are still lagging.

Conflict of interest

The authors declare no conflict of interest.
Author details

Vusumuzi Maphosa\textsuperscript{1}\textsuperscript{*} and Mfowabo Maphosa\textsuperscript{2}

1 National University of Science and Technology, Bulawayo, Zimbabwe

2 University of Pretoria, Pretoria, South Africa

\textsuperscript{*}Address all correspondence to: vusumuzi.maphosa@nust.ac.zw

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