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Examining the Transition to the Fourth Industrial Revolution: Implications on South African Education

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Abstract

Teaching and learning have changed, adapting the use of Information and Communication Technology (ICT), leading to a prompt adoption of advanced tools that will harness teachers' powers to train students to survive in future. However, some teachers are still not aware of the benefits and challenges that it brings. This study examines the transition from the 21st century to the fourth industrial revolution, focusing on the benefits and challenges we might face. This study is a systematic literature review of articles relating to 4IR and education in the past three years. Reading and re-reading these articles informed the researcher to form themes that will be analysed based on South African education and the era's implication on education. The paper was structured in such a way that it enhanced flow and readability. Then, the common core elements and themes were identified: development of relevant skills for teachers and students, sensitisation for change, adaptation to workplace demands, lack of technological skills, uncontrolled devices and benefits of 4IR. The study also discusses the implications of education in South Africa. However, students do not have communication devices; there is also a lack of technical understanding among teachers. Lastly, students will misuse these devices and software for purposes other than learning. This era has the following implications on South African education: disruptions of jobs, causing income

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inequalities; policy-makers will have to design curricula that match employment demands; it will increase education expenditure and enrolment levels; and lastly. Lecturers and teachers will need to be empowered with knowledge and competencies for relevance.

Keywords: technical understanding, infrastructure, fourth industrial revolution, curricula, employment disruption, 21st century skills

Introduction

Education systems globally are currently faced with challenges that call for transformation and innovation in preparing teachers for the teaching profession in the Fourth Industrial Revolution (4IR) (Carrim, 2022). The teaching and learning process has changed because of information and communication technologies (ICT), leading to the prompt adoption of advanced tools that will harness teachers' powers to train students to survive in the future (Grinshkun & Osipovskaya, 2020). Therefore, lifelong learning opportunities and quality and affordable education must be the key priorities to eliminate issues of inequalities in society. Consequently, the COVID-19 pandemic proved to influence education on the use of technology to the degree that priorities were reconsidered to effectively maximise its continuity, relevance and resilience (Uleanya, 2023). Essentially, it has initiated the continuity of the use of technology in schools and higher learning for creative thinking that will transform and reshape future workplaces (Coberly-Holt & Elufiede, 2020). This would mean evolving the teaching and learning strategies relevant to teaching in the Fourth Industrial Revolution (4IR) context. This would also mean students' needs will change and move beyond mere remembrance, recalling and understanding concepts to applying the acquired information outside the classroom. Hence, learning must be personalised to build students' talents and problem-solving skills in the workplace (Ramraj & Marimuthu, 2021).

Research Methodology and Design

This qualitative paper used a literature review to collect data for analysis to update policy-makers and teachers about the 4IR and how it will affect teachers' classroom practices. So, it is reviewed to develop guidelines that policy-makers and teachers need to consider in making an excellent transition to the 4IR. Hence, the researcher searched for literature on the related topic using keywords education and the Fourth Industrial Revolution and its impact on education. After gathering such literature, it was read to analyse those related to the selected topic. Lastly, a review was written on the implications of the Fourth Industrial Revolution on South African education. This is a good literature review which gathers information about a particular subject from many sources. Information about the 4IR and its implications on South African education was gathered in this case. This was well-written and contained no personal biases because the search and selection strategy was clear (Carnwell& Daly, 2001). The researcher tried to structure this review in such a way that it enhances the flow and readability of the review. The type of literature review used in this paper is meta-synthesis, a non-statistical technique for integrating, evaluating, and interpreting the findings of multiple qualitative research studies that review the 4IR on education in general and how it will impact South African education. Such studies may be combined to identify their common core elements and themes. Findings from phenomenological or ethnographic studies were integrated and used for this study. Unlike meta-analysis, where the ultimate intention is to reduce findings, meta-synthesis involves analysing and synthesising vital elements in each study to transform individual findings into new conceptualisations and interpretations (Polit & Beck, 2006).

Findings from the Review

Development of Relevant Skills for Teachers and Students

The use of technology for teaching has become an integral part of success in teaching and learning in schools and higher education, which has benefited many parts of the world. The findings showed that the improvements in schooling are increasing stress, and many

teachers face challenges in integrating skills needed in teaching and learning (Hameed &Hashim, 2022). The challenge is changing teachers' mindsets as critical implementers in addressing students' readiness for future employment markets. Hence, the 4IR has to be introduced in schools and universities. Students and their teachers should be prepared with abilities to enable them to thrive in the 4IR era, where they will see significant advances in their respective subjects. This agrees with Hameed and Hashim (2022) that the traditional curricula that are being used in schools must be adjusted to make subjects more technological without clashing as part of education and that more emphasis be put on critical thinking, problem-solving, communication, teamwork, and inventive thinking abilities as the skills relevant for the 4IR. This implies that teachers must be prepared and willing to integrate technology into their classroom practices if teaching and learning are to be successful because teachers are considered vital components in such classrooms and critical implementers. The 4IR will not merely increase the demand for skills but also put a further force on the pipeline by reshaping the labour market. It is, therefore, predictable that their effective development also requires their scaffolding into co-curricular activities and assessment strategies to be used. Otherwise, South African education can be affected when careful measures are not taken to make relevant demands.

Sensitisation for Change

This may also mean that South Africa's educational system needs to be revised, and retraining programmes supporting 4IR technologies are in order. Even though the current knowledge regarding 4IR is underdeveloped and immature in many sectors, especially the education sector, it should attract the increasing attention of policymakers, teachers, and other academics to prepare students to survive in the future. This is supported by Oke & Fernandes (2020); all stakeholders must be sensitised to be ready and embrace the curricula change. Therefore, schools should start moving towards that time by developing the Fourth Industrial Skills that will unlock new opportunities for the students in the future. This concurs with (Carrim, 2022) that governments should prepare and initiate curriculum changes because those who cannot follow the

appropriate long-term policies will set their economies at risk. This effect requires governments to develop educational policies that will protect their citizens while, on the other hand, reserving the economy. This is the basic policy that governments can follow to reduce employees' risk to straightforward automation. Therefore, South Africa's government should invest in education by training people of all ages to better adapt to new technologies and digitisation. This would be another way of opening youth opportunities to prepare for the 4IR in advance. This is also per the World Economic Forum report (WEF) (2016) that these skills and competence will be required in the technologically disrupted world of work.

Revision of Curricula in South Africa's Schools and Universities

As is the case with other sectors, schools and higher education have to get ready to prepare the students for the 4IR so that they can remain relevant and function well in the world economy. This endorses that specific skills should be incorporated into practical subjects since they encourage the use of learner-centred methods that support deeper learning and higher thinking skills. Importantly, there is also a need for radical change in the subjects taught at universities, colleges, and schools, as well as in the teaching approaches and how students perceive specific skills and tasks. Without revision of the current curricula, South Africa's education will remain traditional, and its people will be stuck with changes. The higher-order skills are the ones that employees are looking for from their employees, so possessing them would mean being relevant. This is echoed by Gray (2016), who states that in changing the mindset of teachers as the key people in addressing the student's readiness for the future employment market, curricula must be aligned to the 4IR needs. Ramraj and Marimuthu also prove that it will allow teachers to build peer-to-peer and student-teacher interactions and create a welcoming learning atmosphere for their students (2021).

Teachers and other stakeholders, like policy-makers in South Africa, must understand the implications of 4IR on education. There should be a starting point in understanding the roles and relevance

of 4IR in facilitating teaching and learning practices. This should be done by acquiring adequate knowledge of different components of 4IR that will reduce face-to-face interactions in schools and higher education in South Africa, using e-materials that are compatible with the learner-centred approach for effective enhancement of students' learning experience as indicated by Oke & Fernandes (2020) in literature. Similarly, the use of technology in education will benefit South Africa's educational institutions by improving teaching and learning, while on the other hand, creating issues and challenges in terms of distraction, lack of technological knowledge and many others for both teachers and students. This means that teaching and learning will not run smoothly when handled by those who are not knowledgeable.

Adaptive to Workplace Demands

The skills considered necessary in the workplace today will no longer be relevant in the future in the 4IR era. Hence, new skills will be required for the new revolution and new technology at work. This could lead to a significant fraction of the population losing their jobs. On the one hand, some people argue that the new revolution will lead to increased job creation. This implies that schools and universities should play a role in making this happen so that people are not left irrelevant for the new jobs created. Furthermore, this is attested by Chisholm (2019) and Gray (2016), who states that teachers need to prepare students to interact and engage with a world infused and changed through technology. This implies that their teacher education must also be adequate for this activity. Students, student-teachers, and lecturers should adapt to this change. This is done to meet the workplace demands that are changing rapidly and will require students to be self-learned. Thus, teachers will have to transition to being facilitators of learning but go beyond personal expertise to allow their students to gain skills and pursue their passions flexibly in the future (Coberly-Holt &Elufiede, 2020). Not only will this emergence make our daily lives more accessible and more straightforward, but it will also be adapted in higher education systems to replace the traditional, teacher-centred and non-interactive teaching strategies that are based on memorisation as indicated earlier, rote learning to task-based approaches (learner-centred) to extend learning beyond the classroom walls. It will

increase the demand for skills and further force the pipeline by reshaping the labour market (Ramraj & Marimuthu, 2021). As this era unfolds, there is also an increasing awareness that its implications for workforce transformation and shifts in workforce demands will profoundly impact the future of workers. Education has to attempt to keep up with these changes to be relevant and meaningful in the future. Hence, the current study determines the impact of moving towards the Fourth Industrial Revolution, focusing mainly on some of the implications on the education system in the South African context using an in-depth assessment of relevant literature.

Lack of Technological Skills

Despite the positive prospects of technology in enhancing teaching and learning and changing the way students experience studies, the nature of teaching and learning, particularly in secondary schools, has not been effectively transformed through digital technologies (Oke & Fernandes, 2020). They further showed that teaching and learning, particularly in South Africa, remained practically static despite using mobile (smart) devices and social media for communication. This means that, like all other man-made educational techniques introduced before, 4IR has some shortfalls. This concurs with Appavoo (2020), who states that teachers are challenged by the anxiety of not finishing the syllabus on time because they believe that ICT-based education takes longer to prepare and implement. On the other hand, it might be that teachers cannot utilise new technologies to their total capacity because they are inadequately trained. So, without appropriate coordination and execution regarding content distribution, the teacher's role and facility of using technology in the classroom can be somewhat intimidating. This is proven by Chaka (2020), who states that a lack of technical knowledge and understanding among teachers can be one of the challenges that teachers might face when implementing innovation and its application in classroom practice situations. When South Africa's teachers lack technical skills and knowledge, it can cause a considerable challenge in technological implementation and practice. This has a high potential of making change invisible. As highlighted by Johnson, Jacovina, Russell, & Soto (2016), sometimes teachers might lack necessary teaching resources like

computers and other applications for teaching that could enable the incorporation of technology into their teaching. This can be viewed as a negative impact of the 4IR on South Africa's education system. This stressing issue applies to teachers and students in South Africa, as they have to work in groups from a single computer, which is likely to cause chaotic situations fighting for it, leading to ineffectiveness during teaching and learning.

Uncontrolled Devices

Despite all the benefits, devices can be used for a different purpose if not controlled. There is a considerable possibility of students misusing technology for purposes other than learning. In this context, teachers and parents need to have significant knowledge regarding using technologies to lock students' devices for making videos at specific times when those are not needed for teaching purposes. When not controlled, technology can contribute negatively as students share misinformation that might also affect other students' learning processes. This concurs with Kayambe & Nel 2020, which states that introducing technology can give rise to negative impacts in terms of misusing technological devices and software. This can end up being a destructor other than being helpful to students. Another stressing issue for teachers is time consumption when installing software and hardware devices, as they do not get enough time to teach due to the excessive time they have to spend on installation. Grinshkun & Osipovskaya (2020) support this; experts must control and manage technology and prepare for the coming classes as it wastes time for teaching. This also affects teachers' roles in effectively and sufficiently completing the syllabus at the end of the school year. The cost of acquiring it will also be affected, which is so high that it will become a massive problem for management teams to install and implement in the classrooms. Consequently, students from lower-income groups will lag as they cannot pay much for their learning in this way. On the other hand, not all schools may have sufficient resources for the implementation, implying that it might create severe issues for teachers.

Benefits of 4IR

Findings show that the education sector, especially in Africa, is unprepared for 4IR, although there are indications for opportunities to harness the potential of the much-anticipated 4IR. Moreover, it demonstrates a typical symbiotic relationship between the education sector and technological innovations, as Butler-Adam (2018) supports. It also shows that 4IR can facilitate students' learning experience and transform the workplace. However, there is a need to assess the learning environment to understand the facilitators and barriers to 4IR diffusion. The opportunity for the education sector to harness the innovations associated with 4IR through research and teaching to enhance students' experience may require a significant improvement in education curricula and investments (Darling-Aduana & Martin (2020). This also contributes to the theory and practice of technology in education and the limited literature on 4IR in the education sector, particularly in Africa (Oke & Fernandes, 2020).

Implication on South African Education

The 4IR presents several implications for skills development in students and the education system in South Africa (Kayembe&Nel, 2019). The Fourth Industrial Revolution (4IR) will accelerate the disruption rate in already experienced jobs, so it is necessary to empower youth to take charge of their education and career strategies. The educational system is not isolated from 4IR technologies, which are predicted to significantly affect learning opportunities, educational policies, and instructional procedures. So, schools and universities should start designing suitable programmes and curricula matching employment. This implies that experts and teachers should start researching more and more to find methods and strategies to ensure that learning helps students become ready for the future. Most education systems in the world have started changing their educational policies and plans to prepare students for the mysterious future where new types of jobs are not yet imagined today and new technologies have not been dreaming about. These technologies affect almost every aspect of our daily lives, including teaching and learning (Moloi & Mhlanga, 2021). Many young people are increasingly becoming unemployed or underemployed, while

employers still have jobs that are not filled up. This challenge is partially rooted in the growing mismatch between youths' skills and employer demands. The problem will likely intensify with the technological revolution's speed if this challenge is not addressed.

One of the implications of the 4IR in the education system is related to curricula, teaching, and learning so that they respond to the current situation (Butler-Adam, 2018). This means reinventing education systems and teaching strategies to increase creativity and innovation for survival. In other words, there must be cross-sector teaching and learning. Where students and teachers from various fields learn about the different factors involved in the successful implementation of the 4IR in terms of teaching and learning, online instruction, and the expanding use of AI necessitate new guidelines to provide a theoretical basis for digital pedagogy (Penprase, 2018). Education is particularly susceptible to wicked problems, especially in the quality of graduates, if students are not well prepared. Furthermore, successfully implementing the 4IR in education will require appropriate skills. Skills are required to implement, manage, and work with new technology and one another (Butler-Adam, 2018). Digital literacy is essential for students to develop adaptive capabilities to participate in the global digital society, benefit from the digital economy, and derive new employment opportunities, innovation, creative expression, and social inclusion (Brown-Martin, 2017). The 4IR calls for transformation in South African teacher education. The challenge, however, is that some of the teachers and students are situated in many rural areas where they do not have access to teaching and learning gadgets; they are not even well-equipped to teach and learn online due to the areas they are working which do not have Internet connections. These challenges brought by the COVID-19 pandemic to learning environments bear witness to the demise of teachers and students living in rural areas. This implies that online teaching proves to be a serious threat to quality teaching and learning in these areas. It is, therefore, evident that 4IR poses a threat to teacher efficacy in these areas.

Inequality and Income Distribution

The other challenges of the 4IR in education in South Africa are inequality and income distribution. There will be unequal societies

that are more likely to experience social issues such as a high crime rate, gender violence and unemployment, among others, as a result of the 4IR as articulated by Keyambe & Nel (2019). There is also a risk that only the wealthy population can afford new technologies for educational purposes. In contrast, the poor population is left behind because of unequal wealth and income distribution. So, countries are trying hard to develop their education systems, especially South Africa, whose education is likely to be affected negatively. It constantly revises and reviews science curricula to provide students with all the competencies and skills that qualify them for future life challenges and industrial revolutions. In the education sector, teachers are pressured to alternate traditional offline lifestyles using digital technologies (Xu et al., 2018). In learning environments, the emergence of advanced technologies also gave birth to what is commonly known as blended learning. Teachers are currently not professionally equipped to use new technologies in teaching and learning. On the other hand, traditional teaching methods are also becoming less relevant because students are exposed to various kinds of media devices such as laptops, smartphones, tablets, digital cameras, and home video game consoles such as PlayStations or Xbox at an early age. This means they are almost ready to use these tools for learning and disrupting lessons when there is little guidance from a teacher (Magano & Ramnarain, 2015).

Cost of Education

Despite these efforts, including increasing education expenditure and enrollment levels, the South African education system remained poor (Department of Education 2018). It continues to be one of the worst education systems in the world. Some of the reasons put forward are the poor performance of students compared to students from other countries at comparable levels of development and high dropout rates in schooling (Department of Basic Education, 2018). This implies that the education sector is not seriously prepared to develop and prepare students for the future. What needs to be inculcated in teachers and students are skills such as interactive, collaborative, critical thinking and problem-solving that match the fast-paced innovation of this 4IR. More arguably, teachers have to be offered professional development to support the development of

active and inquiry-based learning, where teachers encourage students to use pedagogies that allow them to use acquired skills (Darling-Hammond et al., 2017). While this may sound encouraging and compatible with the demands of the 4IR classroom, it is essential to mention that this will be difficult to implement in South Africa.

Training Needed for Lecturers

Teacher education must be reconsidered to accommodate and prepare for the 4IR by empowering lecturers with knowledge and competencies ready to transfer to student-teachers as they come for training. However, challenges such as the COVID-19 pandemic and the encroaching Fourth Industrial Revolution (4IR) have distinctly impacted teacher education. With slow changes occurring in teacher education, adaptation is necessary, and the 4IR might necessitate more in-depth and rapid change. As such, tomorrow's teachers and lecturers are already moulded within a technology-enhanced, knowledge-overloaded society (Seeletso2021). This new context requires sensitivity towards its unique multimodal nature and an increased need for adaptable, lifelong, self-directed students. Teacher educators are more often than not at the battlefront of any change and thus are immersed in the uncertainty that changes in policy creates (Uleanya, 2023). They must implement change in and through initial teacher education programmes that explicitly impact the pre-service teachers enrolled in those programmes. In this respect, they also inexplicitly impact schools and in-service teachers in South Africa and their role as pre-service teachers undertake professional experience. Consequently, teachers must be adaptable and self-directed to acquire what is needed for the changing environment. As Darling-Aduana and Martin (2020) pointed out, teachers also function at the frontline of change. They must be prepared to facilitate students' adaptation to the rapid changes brought on by the 4IR. A critical step in this process is to adequately prepare student teachers to be equipped to handle such circumstances and, therefore, not only be prepared for a specific aspect of the dynamic educational context, such as certain instructional technologies but rather be prepared to be self-directed in their approach to change and be able to unlearn and relearn.

This was highlighted by Penprase (2018) that one thing that is certain about education is that it needs to respond rapidly to the advancement of technological innovation. However, the exact implications for society are still unknown. In other words, South Africa's education needs to lead the 4IR innovation and simultaneously support the development of appropriate high human capital skills. It will also enhance chances for sharing information among teachers and students and develop common instructional technology competencies that may minimise technical challenges and delayed teaching, which Hameed & Hashim (2022) refer to as collaboration). Though many of these 4IR-appropriate curricula ideas have yet to be implemented in the classrooms, significant updates to the curriculum will be required to ensure that schools become centres of knowledge and innovation creation. However, Oke and Fernandes (2020) articulate that the education sector, especially in South Africa's context, is far from being prepared for the 4IR.

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