Effective Education that will be Relevant in the 4IR Era: A Case Study for South African Secondary Schools

Rachel Tholakele Khoza[1], Kgabo Freddy Masehela[2] and Lonah Mbhalati[3]
[1,2,3] University of Johannesburg, Department of Commercial Accounting, Soweto Campus, Republic of South Africa

Abstract

This study explores the impact of digitisation on South African secondary school education, especially in the context of high levels of inequality, exclusion, inadequate funding, inadequate skills, and the absence of a clear integrative national strategy by the Department of Basic Education. The study maps the challenges faced by South African secondary schools regarding the relevancy of the current education curriculum as well as its effectiveness on current practices focusing on the skills that were brought by the Fourth Industrial Revolution (4IR) era. The study contributes to the ongoing discourse on 4IR in the South African education system and brings a nuanced perspective regarding the effects of technological changes in schools as well as how best the secondary school system can take advantage of new technologies. Data collection for the study is ongoing and follows a mixed-methods approach, which strikes a balance between the breadth of challenges faced by secondary schools as well as in-depth understanding of the way schools are handling the challenges. Preliminary findings indicate that a revised curriculum that includes coding, robotics, and data analysis that has been introduced in Foundation Phase and Intermediate Phase must be further developed up to secondary school level. Therefore, there is a need to review the current curriculum to align it with the 4IR practices.

Keywords: *Curriculum Development, 4IR, Department of Education(DBE), Industry 4.0, Secondary Schools*

1. Introduction

The 21st century has been characterised by major changes in the technological space. The world has gone “digital”, which is more evident in the way that organisations and consumers alike use some sort of digital gadgets or devices to conduct business. This new era is referred to as the Industry 4.0, also called the Fourth Industrial Revolution(4IR). 4IR does not only affect business but education too, and as a result, education 4.0 came into existence to respond to the needs of 4IR [5].

Education 4.0 in school curricula is fast becoming a critical need. To keep up with the worldwide digital technology advancement, school curricula must be changed in accordance with 4IR adaptations as soon as possible. Schools can play an integral role in preparing learners for this era by incorporating the skills such as coding, robotics, and data analysis needed for 4IR in the curriculum.

Curriculum changes in schools, as part of the learning revolution, have a significant impact on students' professional abilities. The government should introduce new curricula to build new capabilities for the automation workforce in order to foster a productive synergy with 4IR. Secondary school graduates are not exposed to the new technologies because of limited resources and lack of infrastructure. [9] discovered that some of the major challenges in South Africa (SA) to fullly digitalise the education sector include inequality in SA, the challenge of exclusion, inadequate funding, inadequate skills, and absence of a clear integrative national strategy, among other factors.

The study maps the challenges faced by South African secondary schools regarding the relevancy of the current education curriculum as well as its effectiveness on current practices *focusing on the skills* that were brought by the 4IR era.

2. Review of related literature

2.1. 4IR overview

[12] describes 4IR as technologies that are led by emergence of artificial intelligence (AI), robotics, the internet of things, autonomous vehicles, bio and nanotechnology, 3D printing, material science, quantum computing and energy storage. [12] argues that 4IR technologies will make a significant impact on our lives and will demand a change in current employment and education. [14] states that 4IR will change the way we live, how we work, how the economy works and how we are governed. It will shape the future of education, gender, and work, and consequently the workforce must consider reskilling.

During the 2019 State on the Nation Address (SONA), South African President Cyril Ramaphosa emphasised the urgency of equipping the nation for the 4IR. He emphasised the necessity to adapt and embrace the various opportunities presented by the 4IR. Over the past few years, we have seen lots of jobs being shed due to technological advancements. The workforce has been engulfed by a fear of robots taking over jobs that have previously been done by human beings. These types of changes come with a different set of challenges for the Department of Basic Education (DBE) management. Educational outcomes, for example, can be enhanced by providing children with the critical thinking abilities they will need in a technologically advanced environment.

2.2. Secondary schools' curriculum

According to [10], SA's basic education sector is not prepared for 4IR. One of the consequences of the 4IR in the education sector has to do with curricula, teaching, and learning. Regarding the curriculum, schools should incorporate skills such as coding, robotics, critical thinking, data analysis, problem solving, adaptability, creativity, emotional intelligence, active learning with a growth mindset, judgement and decision-making [1, 8, 6). Schools must establish learning environments that allow students to practise their curiosity, problem-solving abilities, and inquisitiveness as this can help learners to develop a passion for learning, allowing them to make sense of their surroundings through hands-on activities that promote teamwork and creativity.

A revised dynamic and innovative curriculum that includes coding, robotics, and data analysis that has been introduced in Foundation Phase and Intermediate Phase should be further developed up to secondary school level. This curriculum is designed to guide and prepare students to solve problems, think critically, collaborate, be creative, function in a digital and information-driven world, apply digital and Information and Communication Technology(ICT) skills, and transfer these skills to solve everyday problems and opportunities, as well as equip students for meaningful and successful living in a rapidly changing and transforming society [3]. This should also be rolled out in Senior Phase and Further Education and Training(FET) phase (secondary schools) as Piaget's theory of cognitive development (1983) suggests that children from the age of 11 years and upwards can generate potential solutions to the problem in a systematic way [13]. Furthermore, [7] states that at this age children are capable of going beyond their normal thinking capacity. A child is able to construct their thoughts on things that have no existence and can perform a variety of tasks, hypothesising being one of the tasks. To enhance a learner's thoughts at this age, the learner must be placed in a situation where they solve problems. South African high school learners should be well-equipped to enter and be competent in the workplace. This suggests that education 4.0 that is needed to develop skills needed by 4IR should be cultivated at this age.

3. Research methodology

Data collection for this study is ongoing and follows a mixed-methods approach that strikes a balance between the breadth of challenges faced by secondary schools as well as in-depth understanding of the way schools are handling the challenges; however this part of the study will follow a qualitative approach as the study does not seek to mathematically quantify the findings but rather to understand the phenomenon. The study uses content analysis to convert the qualitative data into data suitable to answer the research questions using ATLAS.ti 8™.The secondary data will be collected from all the Grade 12 curriculum documents (which consist of 38 subjects), from the DBE website.

This study mainly followed deductive coding which means that the codes were deduced from an existing theory set of 4IR skills [2]. The process started with preparing a codebook using the 4IR skills as discussed in the literature. The codes were then used to label the 4IR skills in the Grade 12 subject curriculum documents.The researchers used the ATLAS.ti 8™ reports which included the number of occurrences of the skills in the curriculum documents to meet the research objective.

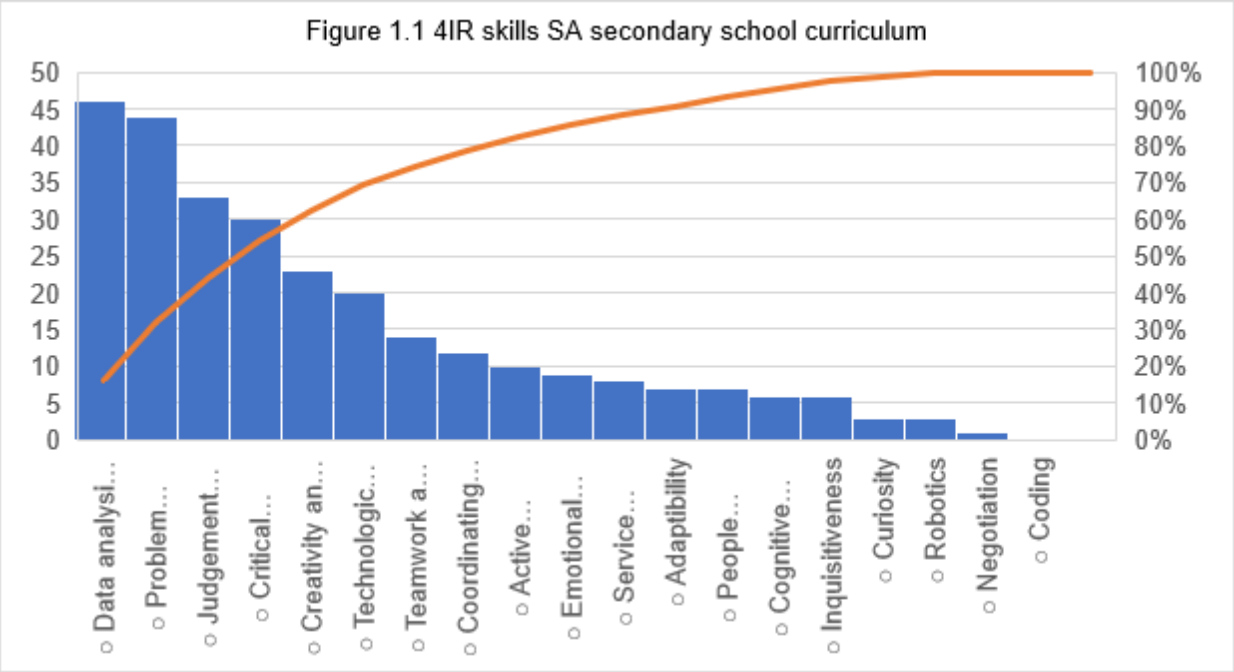
4. Discussion and findings

The results presented were derived from reports generated from ATLAS.ti 8™, which show the number of the skill occurences in the curriculum outcomes in all 38 grade 12 subjects which are tabled below:

Table 1.1 4IR skills in SA secondary school curriculum

4IR skills	Code/skills counts in curriculum documents
○ Data analysis and analytical skills	46
○ Problem solving	44
○ Judgement and decision making	33
○ Critical thinking	30
○ Creativity and innovation	23
○ Technological skills	20
○ Teamwork and collaboration	14
○ Coordinating with others	12
○ Active learning (growth mindset)	10
○ Emotional intelligence	9
○ Service orientation	8
○ Adaptibility	7
○ People management	7
○ Cognitive flexibility	6
○ Inquisitiveness	6
○ Curiosity	3
○ Robotics	3
○ Negotiation	1
○ Coding	0

Source: (authors' own work)



Source: (authors' own work)

The results show that the South African secondary school curriculum already include some 4IR skills. Furthermore, the results reveal that schools place a strong emphasis on data analysis, problem solving, judgment and decision-making, critical thinking, and creativity, all of which are in accordance with the 4IR mandate. [7] backs up the findings by claiming that learners can generate concepts about things that do not exist and can do a range of activities, with hypothesising being one of them. To improve learners' thinking, they must be put in a scenario where they must solve challenges. The secondary school curriculum develops learners and prepares them for 4IR by focusing on the indicated competencies.

However, other skills, such as curiosity, robotics, negotiating, and coding, have yet to be adequately integrated into the curriculum in accordance with 4IR. Although some of the skills are obvious in the curriculum, there is still a gap in the transition to a 4IR-relevant curriculum.

Most of the 4IR skills are visible in subjects such as Marine Sciences, History, Agricultural Management Sciences, Visual Arts and Accounting. This means that these subjects are incorporating some element of 4IR already. There are still subjects that are not yet incorporating any 4IR skills, such as Civil Technology, Civil Technology Bleed and Crops and Mechanical Technology. This is a concern because there are opportunities to introduce a 4IR element in all the secondary school subjects.

5. Conclusion

SA's DBE announced that coding and robotics would be introduced in Grades R to 9 in all schools in light of the country's policy commitment to the 4IR and to ensure that its learners do not fall behind, but nothing has been said about doing the same for FET phase. The curriculum that has been introduced in the Foundation Phase(Grades R-3), which includes coding and robotics, should also be introduced in secondary schools as these skills are a central function in a digital and information-driven world , which requires the application of digital ICT skills to solve everyday problems.

References

[1] Butler-Adam, J. (2008). The Fourth Industrial Revolution and education. *South African Journal of Science*,114(5/6), a0271. https://doi.org/10.17159/sajs.2018/a0271

[2] Cho, J. Y., & Lee, E. (2004) Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences. *The qualitative report, 19*, a64. 2014. https://iribresearch.ir/rm/maghaleh/6.pdf

[3] Department of Education Curriculum and assessment policy statement (DBE). *Grade R-3 robotics and coding.* 2021. https://www.eccurriculum.co.za/Circulars/2021-Circulars/20%20Grade%20R-3%20Coding%20%20and%20Robotics%20Draft%20CAPS%20Final%2019Mar2021.pdf

[4] South African Government (2019). *President Cyril Ramaphosa: 2019 State of the Nation Address.* Availble from: https://www.gov.za/speeches/president-cyril-ramaphosa-2019-state-nation-address-7-feb-2019-0000

[5] Hussin, A.(2018). Education 4.0 made simple: Ideas for teaching. *International Journal of Education and Literacy Studies, 6*(3):92–98. https://doi.org/10.7575/aiac.ijels.v.6n.3p.92

[6] Kayembe, C., & Nel, D. (2019). Challenges and opportunities for education in the Fourth Industrial Revolution. *African Journal of Public Affairs*, 11(3):79–94. https://hdl.handle.net/10520/EJC-19605d342e

[7] Lazarus, S. (2010). *Educational psychology in social context*. 4th edition. Cape Town: Oxford University Press.

[8] Marr, B. (2019). *What is extended reality technology? A simple explanation for anyone.* Forbes. Available from: https://www.forbes.com/sites/bernardmarr/2 019/08/12/what-is-extended-realitytechnology-a-simple-explanation-foranyone/?sh=3551314a7249.

[9] Mhlanga, D. (2020). Industry 4.0 in finance: The impact of artificial intelligence (AI) on digital financial inclusion. *International Journal of Financial Studies*, 8(3), a45. https://doi.org/10.3390/ijfs8030045

[10] Moloi, T., & Mhlanga, D. (2021). Key features of the fourth industrial revolution in South Africa's basic education system. *Journal of Management Information and Decision Sciences*, 24(5).

[11] Saunders, M., Lewis, P. & Thornhill, A. (2009). *Research methods for business students.* 8th edition. Pearson.

[12] Penprase B. E. (2018). The Fourth Industrial Revolution and higher education. In *Higher Education in the Era of the Fourth Industrial Revolution* (pp. 207-229). Edited by Gleason, N. 207–229. Singapore: Palgrave Macmillan.

[13] Piaget, J. (1983). Piaget's theory. In *Handbook of Child Psychology.* 4th edition. Edited by Mussen, P. New York: Wiley.

[14] World Economic Forum (2016). The future of jobs: Employment, skills and workforce strategy for the Fourth Industrial Revolution. Available from: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf