KEY FEATURES OF THE FOURTH INDUSTRIAL REVOLUTION IN SOUTH AFRICA'S BASIC EDUCATION SYSTEM

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ABSTRACT

4IR brings a variety of changes in all the spheres of life, including industry and education. The unprecedented speed of technological innovation characterizes 4IR. Education has attempted to keep up with these changes; however, technology's effectiveness and its challenges are not well documented in this sector. This study seeks to assess the availability of the basic features needed to drive the 4IR in South Africa's basic education system. Essentially, the research question that the study sought to answer was 'what are the key features in place to drive 4IR in South Africa's basic education system'? Data was collected using the interviews. Interviews were conducted through telephone, Zoom, and Microsoft Teams with various school principals.

Our key findings are that the basic education sector in South Africa is not geared for 4IR; however, there are pockets of excellence driven by the private sector. The study found that various online platforms such as WhatsApp/Google Apps, YouTube licensing, Office 365 licensing/ MS Teams and/or Zoom were used to facilitate teaching and learning, mainly in urban schools. The results indicated that many rural teachers were not competent as urban teachers in using technology to teach. Accordingly, teachers relied heavily on traditional teaching methods such as green board and chalk.

This study implies that the South African government must prioritize technologies that can facilitate teaching and learning in the 4IR as many schools did not have these technologies, especially in the rural areas. Very few interviewees understood 4IR and its implications. There is a need for higher learning institutions to design short learning programs aimed at introducing educators to 4IR. After the procurement of technologies in schools, there is usually a tendency to provide overlook the importance of training. As a result, there is a need for training to be intensified on how to operate these technologies for teaching and learning in South Africa.

Key Words: Basic education; Fourth industrial revolution; Technology; South Africa.

INTRODUCTION

Education is pivotal in shaping the strengths and weaknesses of every society, region, or country Kehdinga & Fomunyam 2019) Further, Kehdinga and Fomunyam (2019) indicate that the success of any society in the world is hinged on the level of education among massive advancement in technology, economics, and industrial knowledge. Accordingly, for an economy to compete in the world, education is a central and critical component supports this view. Gwata (2019) stated that education is one of the tools that can help to connect people in the workplace, and it acts as a building block that aids employment. The traditional avenues of employment are increasingly being threatened and some industries are being eroded by emerging technologies of the fourth

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industrial revolution (4IR) (Moloi & Marwala, 2020). This alone demands a reconfiguration of the human perception towards education. Over the years and decades, education has been evolving, each revolution demanded a certain type of approach to be instituted for its overall goal to be achieved and 4IR is not an exception (Kehdinga & Fomunyam, 2019; Moloi & Marwala, 2020).

Traditionally, education has been following a monodisciplinary trajectory which entails narrowing the perspective and focus of one as they go further with their studies. As such, with traditional education, people would obtain a narrow-specialised skill from the educational institution to qualify for a specific trade or job. However, 4IR is impacting all facets of humanity and society (Moloi & Marwala, 2020; Marwala, 2020). It is believed that advances in technology are coming with transformations in business especially in education (Xing & Marwala 2017). Social media applications such as Linkedln and other available online courses are bringing unique ways of dissemination of educational information (Gwata, 2019; Kehdinga & Fomunyam, 2019).

As a result, these platforms transform the mode of teaching and learning, especially the way of communication (Fomunyam, 2019; Oke & Fernandes, 2020). Social media applications like WhatsApp have transformed the way of teaching and how teachers interact with their kids (Mhlanga, 2020). This only shows how technology is changing the education sector. Manasia et al. (2020) argue that despite the wide application of technology in education, its pedagogical and epistemological effects remain questionable. Tymon (2013) has also argued that even though there are a variety of technologies that can be used in facilitating teaching and learning but the sector is lagging when it comes to accepting technology for teaching and learning. Some of the reasons given as obstacles in the acceptance of technology in the education sector are the issue of perceived high costs and the general lack of training. As a result, the effectiveness of technology and its challenges is not well documented in the education sector (Janet, 2010; Manasia et al., 2020).

Masina et al., (2020) also posit that the effectiveness of technology and its challenges associated with its use is not well documented in the education sector. Guilherme, (2019) assessed the current technologization of education and the influence it has on the relationship of a teacher and the learners in the classroom while Berendt et al., (2020) examined the benefits and risks of artificial intelligence in the education sector with a deep focus on the fundamentals human rights. Berendt et al., (2020) discovered that it is critical to have a balance between the benefits and risks of artificial intelligence tools that are deployed and marketed in education. On the other hand, Scepanovic, (2019) argued that the technological revolution that is currently being experienced in the world today implies that the the-education sector should be prepared for the challenges ahead due to the importance of the sector in transforming society for the better. Kayembe & Nel, (2019) also sought to assess the challenges and opportunities for education in the context of the fourth industrial revolution with a direct focus on South Africa. Using desktop research, the research by Kayembe & Nel, (2019) revealed that the challenges that the education sector in South Africa faces in the fourth industrial revolution include lack of funding, improper infrastructure, lack of human, technical and financial capacity. As a result, the current study seeks to assess the availability of the basic features needed to drive the 4IR in South Africa's basic education system using primary data collected through survey data. The research is organized as follows, the first section is outlining the introduction, and the second section explains the education sector in South Arica, while the third section describes the fourth industrial revolution. The theoretical literature review is in the fourth section and the empirical literature review is in the fifth section. The methodology of the study is well explained in the sixth section and results are outlined in the seventh section.

The Education Sector in South Africa

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The education sector in South Africa is divided into three levels, which are the elementary, the secondary level, and finally the tertiary level (Moloi & Dichaba, 2017). In the past, there was one department responsible for education, namely the National Department of Education. This department was responsible for both higher and basic education (elementary, secondary, and tertiary education). After the 2009 general elections, the department was split into two to increase focus on the two different educational systems (Macha, 2020). The Department of Basic Education (DBE) is now responsible for elementary and secondary education while the Department of Higher Education and Training (DHET) is responsible for post-secondary level education, which includes academic institutions and post-secondary technical training (Macha, 2020).

The government of South Africa spends meaningful resources on education, for instance, in 2013 the government spent 19.7 per cent of its total budget on education and about 6 per cent of the country's gross domestic product (GDP) in 2014. The Table 1 below shows the estimates of basic education expenditure as a percentage of total government expenditure compared to other social services.

TABLE 1
SHARE OF BASIC EDUCATION OF TOTAL GOVERNMENT EXPENDITURE AND THE MEDIUM-TERM EXPENDITURE FRAMEWORK (MTEF)

	Basic Education: Share of expenditure as a % of the total budget	**Health: Share of expenditure as a % of the total budget**	**Social Development: Share of expenditure as a % of the total budget**
2014/15	16.8	12.9	12.8
2015/16	16.3	12.8	12.4
2016/17	16.7	13.2	12.7
2017/18	16.7	13.8	12.8
2018/19 MTEF	16.5	13.4	12.9
2019/20 MTEF	16.1	13.3	12.9
2020/21 MTEF	16.0	13.2	12.9

Source UNICEF (2019)

The share of basic education of total government expenditure was the highest compared to social development and health. The education expenditure was reduced from 16.8 per cent to 16 per cent in 2020/21. Over the same period, the share of health spending rose from 12.9 per cent to 13.2 per cent. The spending on social development remained relatively constant over the present MTEF. Education, social development, and health consume 42.1 per cent of total government expenditure in 2018/2019 (UNICEF, 2019, South African Market Access, 2020). The elementary and secondary school systems have been taking the lion's share of the national education budget, for instance, in 2013/2014, 57 per cent of funds were channeled towards elementary and secondary. The percentage has been dropping with an increase in post-secondary education over the years (UNICEF, 2019; Macha, 2020).

The department of basic education

As of 2016, it is estimated that South Africa had 29 749 established public and registered independent schools (Department of Basic Education, 2018). Further, a total of 25 574 were ordinary schools and 4 175 were other educational institutions such as special schools and early childhood development centres (ECD) (Department of Basic Education, 2018). It is also estimated

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that South Africa had 425 000 educators in 2012. This number increased to 440 151 educators in 2016 (South African Market Access, 2020). These educators are spread across district and provincial DBE offices in nine South African provinces and 86 districts, which administer all the schools (Department of Basic Education, 2018). Accordingly, the goals of the DBE and its district and provincial offices are to:

"*improve the quality of teaching, undertake regular assessments, improve early childhood development, ensure a system of outcomes-focused accountability.*"

The elementary and secondary schools in South Africa are most often public and these schools account for the bulk of enrolments (South African Market Access, 2020). In 2016 there were 13 307 830 learners enrolled in all the sectors of basic education in South Africa. From this number 12 342 283 (92.7 per cent) were learners in public schools and 590 282 (4.4 per cent) were in ordinary independent schools. Learners in other ECD centres were 255862 (1.2 per cent) and 119403 were in special schools (South African Market Access, 2020). In the last decade, South Africa has seen a considerable improvement in enrolment levels in elementary education. For instance, between 2003 and 2013, new annual enrollments in grade R doubled, from 300,000 to 705,000 pupils (South African Market Access, 2020).

The Department of Basic Education (2018) cite the poor quality of education as one of the huddles in South Africa despite all the efforts, which include increasing education expenditure and enrollment levels. The education system in South Africa continues to be one of the worst education systems in the world. Some of the reasons put forward are the poor performance of learners compared to students from other countries at comparable levels of development, and dropout rates in schooling are high (Department of Basic Education, 2018). As of 2015, it is estimated that about 20 per cent of children in elementary and secondary schools failed their final year-end school examination (Department of Basic Education, 2018).

The Fourth Industrial Revolution

4IR is described as 'the fusion of technologies that is blurring the lines between the physical, digital, and biological spheres' (Schwab, 2019). In simple terms, the 4IR refers 'to how technologies like artificial intelligence, autonomous vehicles and the internet of things are merging with humans' physical lives' (Schulze, 2019). Klaus Schwab, founder, and executive chairperson of the World Economic Forum (WEF) is credited with coining the term 4IR (Schwab, 2019). The 4IR is also believed to be unique due to the velocity, scope and system impact on the economy and the society that has never been seen before. The 4IR is expected to have far-reaching implications on all the aspects of our daily lives, with an effect on how people interact with technology with massive transformation on how we work, live, and do our work (Schulze, 2019; Moloi & Marwala, 2020; Marwala, 2020). The implications of the 4IR will differ from one country to another and culture will play an important role in this regard. Marwala (2020) often argues that for people to understand the 4IR, they must appreciate the first three industrial revolutions.

The first three industrial revolutions

The industrial revolutions share the same common theme which is the invention of a particular technology that transformed society fundamentally (Schulze, 2019; Moloi & Marwala, 2020; Marwala, 2020). The first Industrial Revolution began in Britain around 1760. This

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revolution was characterized by a major invention in the steam engine. The steam engine allowed the manufacturing process to be mechanized, which allowed the creation of factories. This started the development of urban areas and cities, which also started rural-urban migration (Schulze, 2019; Moloi & Marwala, 2020; Marwala, 2020). The Second Industrial Revolution came around came at the end of the 19th century. This revolution was characterized by mass production in industries like steel, oil, and electricity. Some of the key inventions of this revolution were the light bulb, internal combustion engine and the telephone (Schulze, 2019).

The Digital Revolution characterized the next revolution. The Third Industrial Revolution came with massive inventions in semiconductor, personal computers, and the internet (Schulze, 2019, Marwala, 2020). Two reasons were given as to why the Fourth Industrial Revolution is different from the Third Industrial Revolution. Firstly, the digital, physical, and biological worlds are shrinking to an extent that it is practically difficult to differentiate between these worlds. Again, the rate at which technology is changing is faster than ever (Schulze, 2019; Marwala, 2020). Figure 1 below is all the industrial revolutions from the First industrial revolution to the Fourth Industrial Revolution.

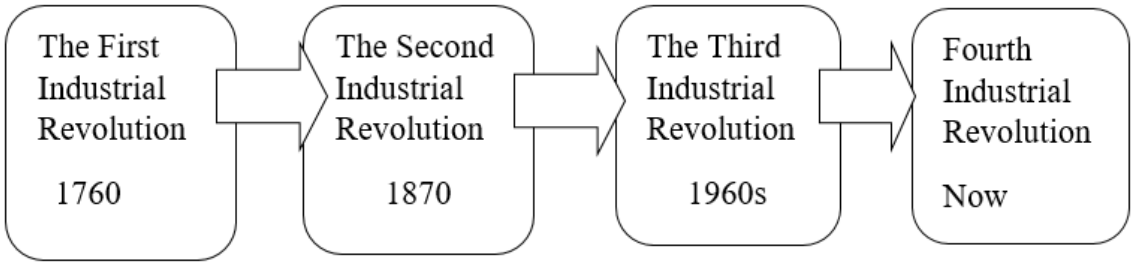

FIGURE 1

THE FOUR INDUSTRIAL REVOLUTIONS

Source: Marwala (2020).

Figure 1 shows all the industrial revolutions from the First Industrial Revolution, which began around 1760 to the Fourth Industrial Revolution.

THEORETICAL LITERATURE REVIEW

The 21st-century society is demanding a lot on its members due to the rapid changes in the political, cultural, social, economic, and technological situations. Personal computers, social networks and platforms, and cell phones which were previously considered frivolous are increasingly impacting the culture of society to an extent that it is very difficult now to survive without them (Magout & Magout, 2020). These technologies are affecting almost every facet of our daily lives including teaching and learning, company operations. Millions of young people are increasingly become unemployed or underemployed, while employers have jobs they cannot fill (Deloitte Global Business Coalition for Education, 2018). It is a challenge partially rooted in the growing mismatch between youths' skills and employer needs. If unaddressed, the problem will likely intensify with the speed at which technological revolution is taking place (Deloitte Global Business Coalition for Education, 2018).

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As a result, society must keep pace with these changing situations and adapt its skills and expertise in all aspects of life (Magout & Magout, 2020). Many people in many societies around the world have a strong belief that various education institutions must provide youth with the required skills expertise required in this revolution. This raises questions on whether the quality of learning and teaching is in line with the demands of the age. This, in turn, puts unprecedented pressure on educational institutions to keep pace with the ever-changing societal needs and expectations. The proliferation of new technology in the communication fraternity have influenced drastic changes in the educational approaches across the world. The kind of skills students require to be prepared for the 21st century is different from what they needed 20 years and odd years ago (Reaves, 2019). Today employers are looking for young people with new skills like problem-solving, interpersonal and team skills. The concepts of lifelong learning and its role in building a knowledge society are also high on the agenda (Moon & Seol, 2017). Any learning which is undertaken should try to support the development of the skills mentioned above, thus, an urgent need to devise new ways of teaching and learning is critical if the government is to prepare students to live, work and prosper in the 21st century. Different modern educational strategies such as self-directed learning, collaborative learning, experimental-based and active learning have emerged (Imenda, 2014).

There is a debate that educators believe that technology has the power to solve many problems associated with the societal change in attitude and delivery of education (Magout & Magout, 2020). New educational technologies increasingly become available, re-thinking conventional practices around teaching and learning is of paramount importance as resources gradually diminish and demand access to better quality higher education dramatically increase. Hence the need to fully investigate the influence of the technological revolution on skills development and the general preparedness of the education sector in skills development. There is no single learning theory to follow in the process of innovating the education sector. Various theories try to explain the issue of innovations in the education sector from a different standpoint of view The connectivism and the engagement theories are the two theories that were considered for this study.

The Connectivism Theory of Learning

Many theories of learning were extremely concerned with learning from printed text without providing alternative interactive and multi-sensory learning environments (Magout, 2020). The new learning theory for the digital age called the connectivism, explain the effect of technology on how we learn, live, and communicate (Siemens, 2006; Downes, 2007). The theory of connectivism combines relevant elements of many learning theories, social structures, and technology to come up with a strong theoretical construct for the digital age. The argument given by Siemens (2006) was that all the learning theories were developed when learning was not influenced by technology.

Due to the explosion of technology, learning is no longer in the control of the learner, technology is now performing many of the operations such as storage of information and retrieval which were the duties of learners (Kop & Hill, 2008). As a result, some knowledge will reside in machines while some will reside in humans (Siemens, 2006; Kop & Hill, 2008). The current challenge, which now faces educators, is to design instruction for machines and humans (Downes, 2007). Siemens (2006) believes that learning way more than the general acquisition of knowledge but rather must be structured with the flow of knowledge in the networks (Magout, 2020). Siemens

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came forth with the principles of connectivism which include, learning and knowledge rest in diversity of opinions, learning is a process of connecting specialized nodes or information sources, learning may reside in non-human appliances, capacity to know more is more critical than what is currently known among others (Dunaway, 2011; Downes, 2014).

Engagement Theory

The idea behind the engagement theory is that engagement of students should be at the centre of learning where students do maximum interaction with other students in worthwhile tasks (Allen & Lester, 2012; Clarà & Barberà, 2013). The meaning of engaged learning is that social interactions and collaborations are important so that learners become involved in a community of practice (Dickey, 2005). In this theory, all students are required to engage in activities that comprise active cognitive processes such as creating, problem-solving, reasoning, decision making, and evaluation (Schneiderman, 1994). Further, engagement creates intrinsic motivation in students to learn due to the nature of the environment created and activities (Schneiderman, 1994). As stipulated by Magout (2020) technology can help to facilitate all aspects of engagement in ways, which are not easy to attain without technology. It is believed that the use of online discussions, conferencing, emails, chat, and video conferencing, can create an environment where engagement among all participants become easy and creative.

Engagement theory is among the new paradigm of theories for teaching and learning in the information age which emphasizes the positive role that technology can play in human interaction and evolution (Reaves, 2019; Magout, 2020). This theory was not derived from other theoretical frameworks for learning, but it is related to the concepts of constructivism, situated learning and experimental learning as these focuses more on collaborative efforts and project-based assignments that result in creative, meaningful, and authentic (Kearsley & Shneiderman, 1998; Magout, 2020).

EMPIRICAL LITERATURE REVIEW

Studies that try to assess the impact of 4IR on education are there but limited. Xing and Marwala (2017) explored 4IR on teaching, research, innovation, and service. They argued that higher education in the 4IR is complex and dialectical with the potential to transform society. They further indicated that 4IR is powered by artificial intelligence which will transform the workplace from task-based features towards human-centred features. Accordingly, Xing and Marwala (2017) concluded that the distance between humanities and social science and technology would be reduced due to the convergence of man and machine. Therefore, it is important to understand that these convergences will require more interdisciplinary teaching, research, and innovation.

Reaves (2019) argued that the education system is changing, and online education can be viewed as the future of education. The question that Reaves poses is what kind of society that will be in line with this type of education? Many futurists and economists were predicting massive disruptions in many industries because of the evolution of the various technologies, which came with the 4IR. It is believed that technologies such as artificial intelligence, nanomaterials, robotics, and additive manufacturing will result in massive changes in industries, which will put pressure on education to conform to these changes. There is an argument that the current structure of education where it is in the form of predefined disciplines and degrees may not be the optimal way in an environment that is volatile, uncertain, complex, and ambiguous (Reaves, 2019). Again, it is believed that the education sector needs restructuring so that degrees and the various disciplines

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teach 21st century skills such as, 'flexibility, adaptability, observation, empathy, creativity, innovation, learning how to learn' (Reaves, 2019). Reaves (2019) went on to state that even online learning needs restructuring so that 21st century skills are taught and be able to be practised.

Waghid et al. (2019) argued that 4IR is changing the way universities operate mainly on the front of teaching and learning in many ways. Waghid et al. (2019) went on to argue that the 4IR can transform the way human interact emanating from the evolution of technology from various fields such as: 'artificial intelligence (AI), robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing.' Further, Waghid et al. (2019) argue that universities in South Africa should prioritize the cosmopolitan human condition that is the amplification of the fusion of technologies across the physical, digital, and biological worlds.

Kehdinga and Fomunyam (2019) also support the idea that education is changing in the 21st century just like what happened in the previous three revolutions. According to Kehdinga and Fomunyam (2019), the social and industrial transformations taking place in the 4IR will explain and provide the new trends in the development of modern engineering education. The main argument that was given was that there is much possibility for engineering institutions to become interdisciplinary and produce entrepreneurial engineers. Kehdinga and Fomunyam (2019) further emphasized educational partnership and industrial cooperation as important attributes to make a trust for future employability of the engineers. In essence, their submission was that for education to be successful in the 4IR, it must be delivered in "partnership with society, industry, employers and the government". For Oke and Fernandes (2020), there is limited knowledge on the acceptability and consequences of the 4IR in the education sector. Using the unified theory of acceptance and use of technology (UTAUT), Oke and Fernandes (2020) found that the education sector, especially in the African continent is not yet fully prepared for the 4IR, therefore, there is a greater need to assess to establish the barriers of 4IR diffusion in education.

METHODOLOGICAL APPROACH

The data for the study was collected from the different groups of respondents both from the supply side and the demand side of education (the basic education sector). Respondents were deputy principals responsible for Teaching and Learning in the basic education sector. Principals and Academic Directors in Primary and High Schools (private and public) were the participants. The study had an ethical clearance by the University of Johannesburg with an ethical clearance number SAREC2020051901.

Sampling Technique

The study was premised on convenience sampling which described as a type of non-probability sampling method where the sample is taken from a group of people easy to contact or to reach (Etikan, 2016). Convenience sampling is also known as grab sampling or availability sampling. There are no unique criteria for the sampling method except that people be available and willing to participate (Etikan, 2016; Sedgwick, 2013). Further, the convenience sampling method does not require that a simple random sample be generated first as the only criteria are whether the participants agree to participate (Etikan, 2016).

The sampling of participants that participated in the data collection process of the research project was influenced by many factors and based on the sample size theories. Firstly, the COVID-19 pandemic in South Africa serious influenced the adoption of the convenience sampling method

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among other reasons such as cost-effectiveness, speed. A total of 145 principals participated in the interviews. In a way to address the bias of conveniently selecting participants, inferences were made specifically on the sample itself due to the difficulties associated with its measurement. Descriptive statistics were used in the analysis of the results together with thematic analysis. To balance the views of the participants, both public and private schools were interviewed. Further, the views of urban and rural schools, as well as primary and secondary/high schools were taken on board. The disadvantages of the method used in selecting participants were taken into consideration and in our case, the disadvantages could not outweigh the benefits. Before the interviews took place, the questions were packaged in an interview instrument. This is the instrument that was used to interview the school principals. Since some schools did not have the technology, such as Zoom or MS Teams, some interviews were conducted via telephone calls. For these schools, audio recordings were made from these discussions. For those schools that had access to related technology such as Zoom or MS Teams, video recordings were made.

RESULTS PRESENTATION AND DISCUSSION

The results presented below relate to some of the questions that participants were responding such as the technologies available for teaching and development activities, competencies of staff members in using these technologies, whether the school has procured any new technology to keep abreast the changing landscape due to the fourth industrial revolution, whether the schools have provided training of staff members on the use of these technologies, the views of the school principals on whether the procured technology is assisting relevant staff members to deliver teaching and development effectively and many other questions as presented in this section. Descriptive statistics were used to present the results of the study. Various themes were highlighted in the process of establishing the implication of the 4IR on basic education in South Africa.

Technology at the Disposal of Schools for Teaching and Developmental Activities

The idea behind the theme was to determine technologies available to facilitate teaching and learning as well as any other developmental activities at school such as sports. In a way to have a clear understanding of the technologies available for teaching and learning activities, researchers requested respondents to reflect on technologies at the disposal of their school for teaching and developmental activities.

Figure 2 indicates that schools deployed nine different types of technologies to facilitate their teaching and development activities (cellphone, smartboards, television, printer/copiers, WiFi/Data, projectors, WhatsApp/Google classes/YouTube licensing, Office 365 licensing/ MS Teams/Zoom, Computing Equipment/ Laptops. Projectors and computing types of equipment were widely used to demonstrate activities in the schools. About 88 per cent of schools had computers while 45% of the schools had projectors and 46 per cent had Wi-Fi/data. The emerging technology that was being used in schools is the smartboards with 34 per cent of schools indicating that they had smartboards.

What is interesting in the data is that some urban schools have introduced WhatsApp/Google classes/YouTube licensing as platforms for teaching and learning. Additionally, urban schools have also started to use Office 365 licensing/ MS Teams/Zoom platforms for teaching and learning. About 15 per cent of schools indicated that they were using WhatsApp/Google Apps for teaching and learning while 9 per cent were using YouTube licensing

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as a platform for teaching and learning, finally, 3 per cent of the schools were using Office 365 licensing/ MS Teams and/or Zoom platforms for teaching and learning. It is important to note that data reflects that the use of these platforms has not been introduced in rural schools especially in the remote parts of the country where connectivity and electricity is a challenge. The other important aspect was to assess the competency of staff to be able to use the existing technology to facilitate teaching and learning. These results were supported by many scholars like Ng'ambi et al., (2016), Kayembe & Nel, (2019). Ng'ambi et al., (2016), came up with a 20-year journey reflecting on technology-enhanced learning. Though Ng'ambi et al., (2016), outlined some technologies the results of the current study showed that the number of technologies used now in the education sector has improved with the introduction of learning management systems.

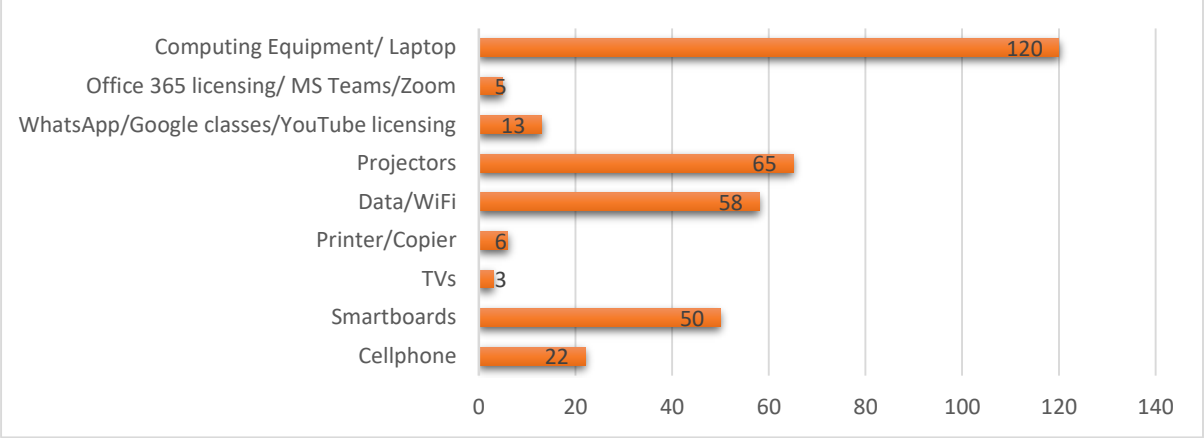

FIGURE 2

TECHNOLOGIES AT THE DISPOSAL OF THE SCHOOLS IN SOUTH AFRICA

Competency of Staff Members in Using the Existing Technology

The purpose of this question was to determine the competence of staff members in using the existing technologies available for teaching and learning at each school that was interviewed. To determine the competence of staff members, researchers requested the principals or designated individuals to reflect on the competence of staff members in using the technologies at the disposal.

TABLE 2
COMPETENCY OF STAFF MEMBERS IN USING THE EXISTING TECHNOLOGY.

Competency of staff members	Provinces								
	EC	FS	GP	KZN	L	MP	NC	NW	WC
Competent	2	6	4	2	4	18	7	2	12
Moderately competent	5	10	5	2	5	18	4	6	1
Not competent	5	0	3	8	3	8	1	4	0
Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Competent	18	38	33	17	33	41	58	17	92
% Moderately competent	45	62	42	17	42	41	8	50	8
% Not competent	36	0	25	66	25	18	34	33	0

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Table 2 indicates that most principals in schools are of the view that the teaching staff is sitting between moderately competent to compete in the use of existing technologies for teaching, learning and any other developmental activities. Approximately 39 per cent of the principals indicated that teaching staff were moderately competent to competent, while 23 per cent indicated that their staff were not competent at all in operating the existing technology. When the information was analyzed per province, the data showed that Western Cape was the province with the highest number of principals who indicated that their staff members were competent in using the available technology, followed by Northern Cape and Free state. The data also highlighted that most urban schools are the largest contributors to the category of competence in the use of existing technologies for teaching and developmental activities. It is important to note that data indicates that most principals in rural schools leaned more towards the not competent or moderately competent category. Scholars like Waghid et al. (2019), Kehdinga and Fomunyam (2019), and Kayembe & Nel, (2019), also found the same results. The authors highlighted that in South Africa, it is very important for educators to be competent in operating the various technologies so that the sector can move towards embracing the demands of the fourth industrial revolution. One of the obstacles for the digital transformation of the education sector was a lack of competency and training especially among the educators in the rural areas (Kayembe & Nel, 2019; Mhlanga & Moloi, 2020).

Procurement of New Technologies to Keep Abreast with Technological Advances

The other important aspect that the study intended to assess whether the schools have procured any new technology to keep abreast of the changing landscape due to the 4IR. In this regard, principals or designated personnel were requested to indicate any new technology that would have been acquired/ added to keep abreast of technological advances.

The results demonstrate that there was not much that was procured to keep abreast of the changing landscape due to the 4IR. Approximately 11 per cent of the schools indicated that they had procured computers while 8 per cent of the schools highlighted that they had installed Wi-fi at school. Of interest from the data is the urban schools mostly driven by public schools, there were some efforts to introduce technology such as robotics and coding applications in schools. Approximately 2 per cent of the schools did indicate that they had already introduced robotics and coding in their schools. Some schools were introducing 3D Printers in their schools and about 0.5 per cent of the schools and those introducing laser cutting machines were also approximately 0.5 per cent. These technologies were used as part of teaching and learning as well as any other developmental activities. Additionally, as indicated before private schools are also introducing WhatsApp/Google classes/YouTube licensing (5 per cent), Office 365 licensing/ MS Teams/Zoom (1 per cent) while public schools are procuring basic computing equipment like projectors and smartboards in some circumstances (Figure 3). In short, public schools are seeing a surge in the procurement of basic computing infrastructure such as projectors. This is in line with the results reported by many scholars who indicated that in South Africa, the use of technology is biased towards urban schools when compared with rural schools. Scholars like Meyer and Gent (2016), Oke and Fernandes (2020), among others reiterated the fact that in South Africa there is a digital divide where the gap between those who have and those without is very high.

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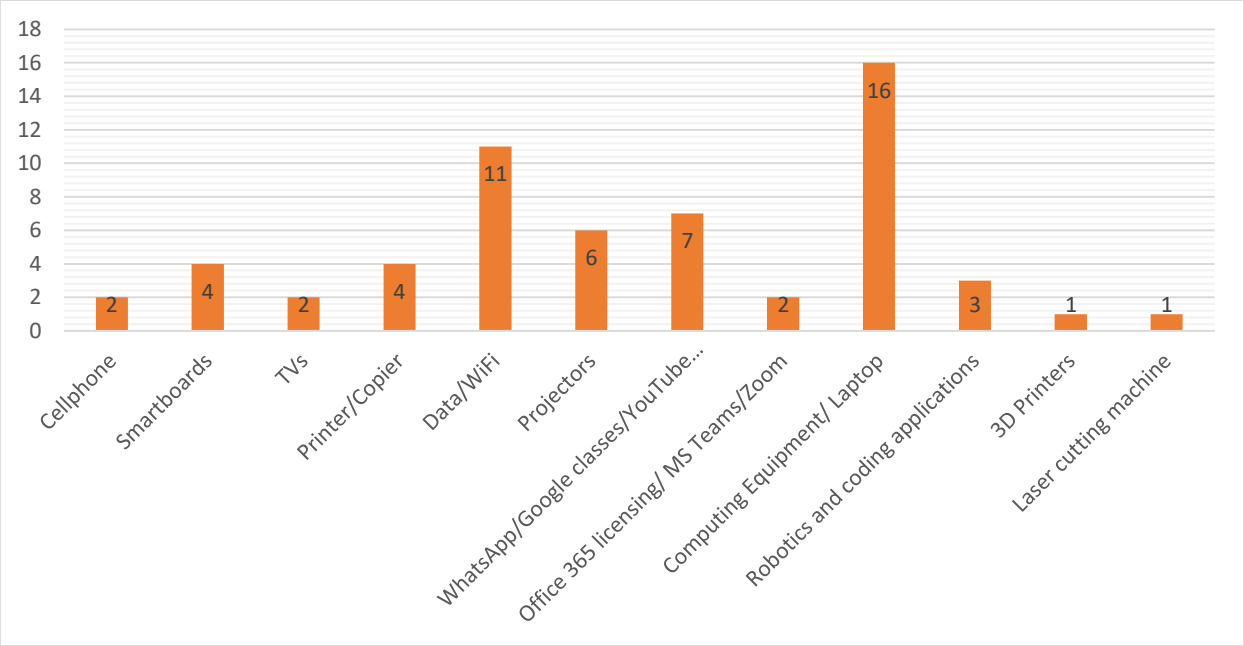

FIGURE 3

PROCUREMENT OF NEW TECHNOLOGIES TO KEEP ABREAST WITH TECHNOLOGICAL ADVANCES IN THE 4IR

Training of Staff Members to Work on (Operate) the Newly Acquired Technology

One of the important aspects was to determine whether schools had provided training of staff members on the use of the newly procured technologies. Researchers requested the principals or the designated respondents to indicate whether the training had been provided or not. Table 3 is giving the number and percentages of schools that had provided training for their members on the newly procured technology.

TABLE 3
TRAINING OF RELEVANT STAFF TO WORK WITH (OPERATE) NEW TECHNOLOGIES

Training of staff members	Provinces								
	EC	**FS**	**GP**	**KZN**	**L**	**MP**	**NC**	**NW**	**WC**
Training provided	1	0	2	1	5	4	0	1	2
Training not provided	0	1	1	0	1	2	0	0	0
Not applicable	11	15	9	11	6	38	12	11	11
Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Training provided	8	0	17	9	42	9	0	8	15
% Training not provided	0	7	8	0	8	5	0	0	0
% Not applicable	92	93	75	91	50	86	100	92	85

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The results revealed that most principals or designated officials indicated that there was no training that they had arranged or conducted for the teaching staff in their respective schools. For instance, in Eastern Cape, 92 per cent of principals interviewed indicated that no training was provided while in Northern Cape 100 per cent of principals indicated that no training was provided. Schools that had made some procurement, the indication was that they arranged some forms of 'crash courses or short courses' to other staff members on how to operate the technology which had been acquired, Principals and designated officials indicated that it was essential to have training on general emerging technologies, and to eventual have these technologies in their schools. They viewed this as essential for the teaching and learning and the development of children. Also, since the urban schools had driven more procurement of technologies, specifically private schools, data generated from the interviews is consistent with this as it indicates that the urban schools were drivers of training on how to operate new technologies. It is important to note that many rural schools do not have the technologies that are related to the 4IR as well as lacking the training required to operate the technologies.

Value Proposition and Relevance of the Newly Procured Technology

The other aspect that was supposed to be investigated was for principals or designated officials to give their views on whether procured technology is assisting relevant staff members to deliver teaching and development activities effectively. This question's main aim was to determine whether principals saw the newly acquired technology as the value add to its teaching and learning process.

Table 4 indicates that the value addition question did not apply to most schools as they had not purchased any new technology infrastructure for instance, in KZN, Limpopo and Free State the question was not applicable at all. There was 100 per cent not applicable in these provinces. Most schools that had added some technology in one form or the other were beginning to see the benefit. For instance, 33 per cent in Eastern Cape province, 20 per cent in Gauteng province, and 10 per cent in Mpumalanga, Northern Cape, and Western Cape while North-West had 5 per cent. Other provinces like Free State, Kwazulu Natal and Limpopo had 0 per cent. One of the themes that emerged here is that in those schools that had purchased online teaching platforms such as WhatsApp/Google classes/YouTube licensing, Office 365 licensing/ MS Teams/Zoom, they were able to provide classes during the national lockdown. The emerging theme for those that indicated that they had not seen the value in the procured technology was that fewer teachers had received training on the use of technology.

TABLE 4
VALUE CREATION OF NEW TECHNOLOGY IN ASSISTING STAFF MEMBERS TO DELIVER TEACHING AND LEARNING EFFECTIVELY

Value creation	Provinces								
	EC	FS	GP	KZN	L	MP	NC	NW	WC
Value realized	1	1	2	1	5	1	0	1	2
Value not realized	0	0	1	0	0	2	0	0	0
Not applicable	11	15	9	11	7	41	12	11	11

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Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Value realized	33	0	20	0	0	10	10	5	10
% Value not realized	0	0	5	0	0	0	0	0	0
% Not applicable	67	100	75	100	100	90	90	95	90

Challenges Associated with Institutionalizing Technology

The study also sought to assess and determine the challenges associated with institutionalizing technologies within the schools. Participants were requested to indicate all the challenges they are currently facing as they attempt to make technology part of teaching and learning activities within their schools.

TABLE 5
CHALLENGES ASSOCIATED WITH INSTITUTIONALIZING TECHNOLOGY

Challenges	**Provinces**									
	EC	**FS**	**GP**	**KZN**	**L**	**MP**	**NC**	**NW**	**WC**	**Total**
Rural/Poor/Funding	6	15	10	6	9	29	11	7	6	99
Negative Attitude	2	0	2	3	2	11	2	0	1	23
Aging Workforce	1	1	0	0	1	6	0	0	1	10
Security/Vandalism	3	0	3	3	2	11	0	1	0	23
Support from service providers/Training/ Skills (shortage of skilled personnel)	5	5	4	6	1	10	5	4	5	45
Stability of the electricity grid	1	2	0	2	0	2	0	2	2	11
Connectivity	7	2	1	5	3	9	2	8	2	39
Balancing technology and discipline	0	0	0	1	1	0	0	1	0	3

The results in Table 5 highlight that the main challenges of schools in institutionalizing technology are that they lack funding with 68 per cent of schools highlighting the challenge. This was a dominating theme in most of the schools that were interviewed. Another theme that emerged from the data that was analyzed was the lack of support from service providers/training/ skills or simply a shortage of skilled personnel with 31 per cent. This means that many schools even though they have the technology many of them do not have the skills to operate and even to maintain the gadgets. This means that without proper funding it will be very difficult to use the procured infrastructure if anything happens on the procured infrastructure (damage), it will take some time to get it repaired. Some schools raised the challenge that much as technology is an opportunity that should be leveraged for teaching and learning, specifically cellphones and making connectivity available to scholars, a way must be found where this can be done in a balanced manner to maintain discipline. This means that technology is good for children if balance is achieved to ensure that the kids are not affected discipline wise.

Policy Direction from Authorities/Shareholders on Matters Relating to 4IR

The purpose of this construct was to determine and understand whether the institution has received any policy direction from authorities/its shareholders on the 4IR.

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TABLE 6
POLICY DIRECTION FROM AUTHORITIES/SHAREHOLDERS ON MATTERS RELATING TO 4IR

4IR policy direction	Provinces								
	EC	**FS**	**GP**	**KZN**	**L**	**MP**	**NC**	**NW**	**WC**
Yes	1	0	0	0	0	0	0	1	2
No	11	16	12	12	12	44	12	11	11
Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Yes	0	0	5	10	0	0	0	5	5
% No	100	100	95	90	100	100	100	95	95

The results indicated that very few schools managed to receive policy direction on 4IR. Some schools indicated that there were ongoing visits from the district offices, however, these visits or telephone calls were done for inspection purposes. Only 15 per cent, of schools in 10 per cent of the schools in Kwazulu Natal and 5 per cent in the Western Cape, North-West and Gauteng province indicated that they received some form of policy direction from the authorities. The overwhelming number of principals or designated officials that were interviewed indicated that the authorities had not mentioned the importance of the use of technology in teaching and development activities. For instance, all the principals in Limpopo, Mpumalanga, Northern Cape, Northern Cape indicated that they did not receive policy direction on 4IR issues (Table 6).

Formulation of 4IR or Technology Strategy/Plans/Activities

With this question, researchers sought to determine and understand whether the schools interviewed had formulated the fourth industrial revolution/ technology-related strategies/ plans/ activities.

TABLE 7
FORMULATION OF 4IR OR TECHNOLOGY STRATEGY/PLANS/ACTIVITIES

4IR strategy/plans/activities	Provinces								
	EC	**FS**	**GP**	**KZN**	**L**	**MP**	**NC**	**NW**	**WC**
Formulated	6	0	1	3	2	2	4	0	7
Not formulated	6	16	11	9	10	42	8	12	6
Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Formulated	50	0	5	0	0	0	15	0	0
% Not formulated	50	100	95	100	100	100	85	100	100

The results indicated that even though some public schools may not have received the policy directions on 4IR from authorities, some principals indicated that they had formulated the 4IR/ technology-related strategies/ plans/ activities based on their exposure to this phenomenon. For instance, 58 per cent in Western Cape and 50 per cent in Eastern Cape had formulated some plans. In addition, some indicated that their SGGBs were driving these activities. Those that had not taken any initiative indicated that they would be guided by the policy direction from authorities once made available. Almost 100 per cent of principals interviewed in North-West and Free State indicated the plans were not formulated, followed by 95 per cent in MP. Private sector schools had

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formulated the fourth industrial revolution/ technology-related strategies/plans/activities because that is the new direction and strategic objective that they were executing (Table 7).

Access to Technology as A Condition for Meaningful Participation in Teaching and Development

The purpose of this construct was to investigate whether scholars in the schools had access to and benefit from technology as part of their learning and development. The construct was also there to assess the availability of gadgets and general technology infrastructure in their homes. Researchers requested the respondents to reflect and highlight the extent to which they think their scholars would be able to meaningfully participate in teaching and development activities based on the availability of gadgets and general technology infrastructure in the scholar's homes.

TABLE 8
ACCESS TO TECHNOLOGY INFRASTRUCTURE BY SCHOLARS FOR MEANINGFUL PARTICIPATION IN TEACHING AND DEVELOPMENT

The extent to which technology is available at home	Provinces								
	EC	**FS**	**GP**	**KZN**	**L**	**MP**	**NC**	**NW**	**WC**
Greater extent	2	2	4	1	2	2	2	1	5
Moderate extent	4	13	8	7	6	34	9	10	7
No extent	6	1	0	4	4	8	1	1	1
Total Responses	**12**	**16**	**12**	**12**	**12**	**44**	**12**	**12**	**13**
% Greater extent	17	13	33	8	17	5	17	8	38
% Moderate extent	33	81	67	58	50	77	75	84	54
% No extent	50	6	0	34	33	18	8	8	8

After interviewing the principals or relevant officials on their views on the extent to which students have sufficient technological infrastructure (particularly at home) to be able to participate meaningfully in teaching and development activities. Many principals were of the view that the extent to which learners had technology was moderate. For instance, 84 per cent of principals in North-West and 81 per cent in Free State were of the view that learners had moderate access to technology. The key driver to this theme is that schools, in general, had not procured much of the latest technology to drive teaching and development activities. Most principals that indicated that there was no extent to which scholars had enough technological infrastructure (particularly at home) to be able to participate meaningfully in teaching and development activities were from rural schools (Table 8).

Anticipated Challenges as Schools Look Towards Using Technology

This question requested Principals or designated officials to provide a forward-looking assessment of the potential challenges that their schools could experience as they look towards the use of technology in their schools.

TABLE 9
ANTICIPATED CHALLENGES ASSOCIATED WITH INSTITUTIONALIZING NEW TECHNOLOGY

	Provinces

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Challenges	EC	FS	GP	KZN	L	MP	NC	NW	WC
Rural/Poor/Funding/Cost	2	8	9	5	10	33	8	9	8
Negative Attitude	0	1	2	1	1	8	1	0	2
Ageing Workforce	0	0	0	0	2	4	0	0	0
Security/Vandalism	4	6	9	0	4	18	1	4	3
Service providers/Training/ Skills (skilled personnel)	4	4	3	4	4	11	3	5	3
Stability of the electricity grid	8	4	4	8	7	4	6	5	5
Connectivity	0	0	1	0	1	8	3	3	2
Balancing technology with discipline	0	0	0	1	0	3	0	0	0
Shortage of infrastructure and computing equipment	0	0	0	0	0	15	0	0	0
Support from parents	0	1	0	0	0	0	0	0	0

Data obtained from conducted interviews indicate that the main challenges of the schools are a lack of funding with 63 per cent of schools highlighting the factor. This was a dominating theme in most schools. Other challenges identified were the stability of the electricity grid with 35 per cent the potential of vandalism with 34 per cent and support from service providers /lack of training was at 28 per cent, connectivity was 12 per cent. The negative attitude was another challenge was at 11 per cent shortage of computing infrastructure 10 per cent were all also identified as key themes that the interviewed principals assessed that their schools could experience as they look towards intensifying the use of technology (Table 9).

Additional Support Required to Enable the Delivery of the Cohorts of Scholars Ready to Enter the Market that is Powered by Technology

Principals or designated officials in the schools were requested to indicate additional support they require to teach and support the development activities so that the cohort of scholars would be ready to move to the next phase of education having been exposed to technology.

TABLE 10
ADDITIONAL SUPPORT REQUIRED TO DELIVER THE COHORT OF SCHOLARS READY TO ENTER THE NEXT PHASE OF EDUCATION, LIKELY TO BE POWERED BY TECHNOLOGY

Technologies and skill need	Provinces								
	EC	FS	GP	KZN	L	MP	NC	NW	WC
Training	9	12	9	7	7	39	10	11	4
Computing equipment/computer laboratory	11	16	9	7	11	39	10	9	5
Connectivity	1	6	2	3	6	27	5	6	3
Funding	1	0	1	1	6	24	3	1	4
Technology experts/ Curriculum guidance	6	1	1	2	1	26	4	2	3
Security	3	1	1	2	2	13	1	1	0
TV	0	1	1	0	5	29	0	0	0
Stable power source	0	1	1	1	0	4	0	1	0
Reliable technology service providers	0	0	0	1	0	0	0	0	0

Principals or designated officials that were interviewed identified nine essential needs as the additional support they require to teach and deliver the cohort of scholars ready to enter the

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next phase of education, expected to be powered by technology. Data obtained from the conducted interviews indicate that Principals or designated officials mostly require computing equipment/ computer laboratories (81 per cent), require staff training (74 per cent), internet connectivity (41 per cent). Similarly, to the ECD centres, some Principals or designated officials in schools indicated that it would be beneficial to have technical advice (32 per cent) in the form of experts on curriculum guidance as this will be incorporating technology (Table 10). Another critical emerging theme is the security (17 per cent) and stable power source (6 per cent) as a need for the schools. It is important to note that most of the requirements from the principals in schools were in line with what many scholars highlighted as the prerequisites for ushering the education sector in the fourth industrial revolution. Scholars like Meyer and Gent (2016), Oke & Fernandes (2020), Kayembe & Nel, (2019), also pointed out that schools require computing equipment, require staff training, internet connectivity among several other recommendations. The needs of the principals in schools cut across the sector from private to public schools. These requirements were viewed as essential for schools to teach and deliver the cohort of scholars ready to enter the next phase of education, expected to be powered by technology.

CONCLUSION AND POLICY RECOMMENDATION

A basic review of the literature indicates that education is being transformed from the traditional monodisciplinary trajectory which entails narrowing the perspective and focus of one as they go further with their studies towards a multidisciplinary approach because of the advances in technology brought by the 4IR. This study sought to determine and understand the basic tenets in place to drive 4IR in South Africa's basic education. Essentially, the research question that the study sought to answer was 'what are the key features in place to drive 4IR in South Africa's basic education system'?

Data was collected using the interviews. Interviews were conducted through telephone, Zoom, and Microsoft Teams with various principals and/or deputy principals. Our key findings are that while various online platforms such as WhatsApp/Google Apps, YouTube licensing, Office 365 licensing/ MS Teams and/or Zoom were mainly utilized in urban schools. Concerning competency, the results indicated that many rural teachers were not competitive compared to urban teachers in using technology for teaching and learning. Accordingly, teachers relied heavily on the traditional methods of teaching such as green board and chalk mainly in rural areas. The results indicated that there was not much technology infrastructure procured for teaching and learning, to keep abreast of the changing landscape due to the 4IR. In general, there was a surge in the procurement of basic computing infrastructure in public schools.

Further findings revealed that most principals indicated that there was no training that they had arranged or conducted for the teaching staff in their schools to operate modern technology. This was because many rural schools/public schools had procured less technological material. For those that had made some procurement, the indication was that they arranged some forms of 'crash courses' to other staff members on how to operate the basic technology which had been acquired. Concerning value addition, the majority of those that had added some technology in one form or the other attested to deriving benefits associated with this. On the other hand, many rural schools did not see any value from the new technologies because some of their staff members were not trained to operate these technologies.

This study implies that the South African government must prioritize the procurement of technologies that can help to facilitate teaching and learning in the 4IR as many schools did not

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have these technologies, especially in the rural areas. Very few interviewees understood 4IR and its implications, there is a need for institutions of higher learning to design short learning programs aimed at introducing educators to 4IR. Usually, after the procurement of technologies, there is a tendency to overlook the importance of training. There is a need for training to be intensified on how to operate these technologies for teaching and learning. The research was limited to basic education it will be a rewarding endeavor to extent the research to all the education sectors like higher education. It is important for future research to include higher education in the analysis of the availability of the basic features needed to drive the 4IR in South Africa's basic education system.

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REFERENCES

Allen, I. H., & Lester, S. M. (2012). The Impact of a College Survival Skills Course and a Success Coach on Retention and Academic Performance. *Journal of Career and Technical Education, 27*(1), 2012-2020.

Berendt, B., Littlejohn, A., & Blakemore, M. (2020). AI in education: learner choice and fundamental rights. *Learning Media and Technology*, *45*(3), 1-13.

Clarà, M., & Barberà, E. (2013). Learning online: massive open online courses (MOOCs), connectivism, and cultural psychology. *Distance Education, 34*(1), 129-136.

Deloitte Global Business Coalition for Education. (2018). *Preparing tomorrow's workforce for the Fourth Industrial Revolution*. *Deloitte*, About, 1-58.

Department of Basic Education. (2018). *Education Statistics in South Africa, 2016*. Pretoria, South Africa.

Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. *Educational Technology Research and Development, 53*(2), 67-83.

Downes, P. (2014). *Access to Education in Europe: A framework and agenda for system change*. Springer.

Downes, S. (2007). *What Connectivism Is, Half An Hour*. Retrieved from http://halfanhour.blogspot.ro/2007/02/what-connectivism-is.html

Dunaway, M. K. (2011). Connectivism: Learning theory and pedagogical practice for networked information landscapes. *Reference Services Review*, *39*(4), 675-685.

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4.

Fomunyam, K. G. (2019). Education and the Fourth Industrial Revolution: Challenges and Possibilities for Engineering. *International Journal of Mechanical Engineering and Technology (IJMET), 10*(08), 271-284.

Guilherme, A. (2019). AI and education: the importance of teacher and student relations. *AI and Society, 34*(1), 47-54.

Gwata, M. (2019). To flourish in the Fourth Industrial Revolution, we need to rethink these 3 things. World Economic Forum. Retrieved from https://www.weforum.org/agenda/2019/08/fourth-industrial-revolution-education/https://www.education.gov.za/Programmes/EMIS/StatisticalPublications.aspx

Imenda, S. (2014). Is There a Conceptual Difference between Theoretical and Conceptual Frameworks? *Journal of Social Sciences*, *38*(2), 185-195.

Kayembe, C., & Nel, D. (2019). Challenges and Opportunities for Education in the Fourth Industrial Revolution. *African Journal of Public Affairs, 11*(3), 79-94.

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. *Educational Technology, 38*(5), 20-23.

Kehdinga, D., & Fomunyam, G. (2019). Education and The Fourth Industrial Revolution: Challenges and Possibilities for Engineering Education. *International Journal of Mechanical Engineering and Technology, 10*(8), 271-284.

Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past? *International Review of Research in Open and Distance Learning, 9*(3), 1-13.

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Macha, W. (2020). *Education in South Africa*. Retrieved from https://wenr.wes.org/2017/05/education-south-africa
Magout, M. (2020). Theoretical Framework and Literature Review. In *A Reflexive Islamic Modernity*, pp. 29-56.
Manasia, L., Ianos, M. G., & Chicioreanu, T. D. (2020). Pre-service teacher preparedness for fostering education for sustainable development: An empirical analysis of central dimensions of teaching readiness. *Sustainability (Switzerland), 12*(1), 4-6.
Marwala, T. (2020). *Closing the gap: The Fourth Industrial Revolution in Africa*. Macmillan, Johannesburg, South Africa.
Mayer, R. E. (2014). Cognitive theory of multimedia learning. In *The Cambridge Handbook of Multimedia Learning*, pp. 43-71.
Meyer, I. A., & Gent, P. R. (2016). *The Status of ICT in Education in South Africa and the Way Forward.* Centurion: The National Education Collaboration Trust (NECT). Retrievef from http://nect.org.za/publications/technical-reports/the-state-of-ict-in-education-in-south-africa/view
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), 45.
Mhlanga, D., & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4ir in South Africa? *Education Sciences, 10*(7), 180.
Moloi, T., & Dichaba, M. (2017). The Usefulness of TVET College's Websites as an Information Centre to Potential Students. *International Journal of Innovation Management and Technology*, *8*(3), 207-212.
Moloi, T., & Marwala, T. (2020). *Artificial Intelligence in Economics and Finance Theories*. Springer, Netherlands.
Moon, Y., & Seol, S.-S. (2017). Evaluation of the Theory of the 4th Industrial Revolution 1. *Asian Journal of Innovation and Policy, 6*(May), 245-261.
Ng'ambi, D., Brown, C., Bozalek, V., Gachago, D., & Wood, D. (2016). Technology-enhanced teaching and learning in South African higher education - A rearview of a 20-year. journey. *British Journal of Educational Technology, 47*(5), 843-858.
Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th industrial revolution (4IR). *Journal of Open Innovation: Technology, Market, and Complexity, 6*(2), 31.
Reaves, J. (2019). 21St-Century Skills and the Fourth Industrial Revolution: a Critical Future Role for Online Education. *International Journal on Innovations in Online Education, 3*(1), 029705.
Scepanovic, S. (2019). The Fourth Industrial Revolution and Education. *Proceedings of 8th Mediterranean Conference on Embedded Computing, MECO 2019*.
Schneiderman, B. (1994). *Education by Engagement and Construction: Can Distance Learning be Better than Face-to-Face?* Retrieved from http://www.hitl.washington.edu/scivw/EVE/distance.html
Schulze, E. (2019). *What is the Fourth Industrial Revolution Davos 2019?* Retrieved from https://www.cnbc.com/2019/01/16/fourth-industrial-revolution-explained-davos-2019
Schwab, D. (2019). *How artificial intelligence is redefining the role of the manager*. Davos World Economic Forum. Retrieved from https://www.weforum.org/agenda/2019/11/how-artificial-intelligence-is-redefining-the-role-of-manager/
Sedgwick, P. (2013). Convenience sampling. *BMJ*, *347*, f6304.
Siemens, G. (2006). Technology connected futures Connectivism: Learning and Knowledge Today George Siemens. *Proceedings of Global summit 2006*. Retrieved from http://www.mmiweb.org.uk/egyptianteachers/site/downloads/Siemens_2006.pdf
South African Market Access. (2020). *Education Statistics - South African Market Insights*. Retrieved from https://www.southafricanmi.com/education-statistics.html
Tymon, A. (2013). The student perspective on employability. *Studies in Higher Education, 38*(6), 841-856.
UNICEF. (2019). *Education Budget Brief*. Retrieved from https://www.unicef.org/esaro/UNICEF-South-Africa-2018-Education-Budget-Brief.pdf
Waghid, Y., Waghid, Z., & Waghid, F. (2019). The fourth industrial revolution reconsidered: On advancing cosmopolitan education. *South African Journal of Higher Education, 33*(06), 1-9.
Xing, B., & Marwala, T. (2017). Implications of the Fourth Industrial Age on Higher Education. ArXiv, abs/1703.09643.

Citation Information: 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), 1-20.