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THE TECHNOLOGY HURDLES: CHALLENGES SOUTH AFRICAN TEACHERS FACE IN INTEGRATING 4IR TECHNOLOGY INTO EDUCATION

LOS OBSTÁCULOS DE LA TECNOLOGÍA: DESAFÍOS A LOS QUE SE ENFRENTAN LOS PROFESORES SUDAFRICANOS PARA INTEGRAR LA TECNOLOGÍA 4IR EN LA EDUCACIÓN

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ABSTRACT

In the 21st century, where things are constantly changing, technology is both a force for progress and a difficult obstacle. Technology has changed our lives in many ways, from the ease of use of smartphones and the Internet of Things to the development of AI and educational tools. But along with these amazing technological advances come a lot of hard problems that need to be solved before technology can be fully integrated into schools. This study explored the challenges South African schools face in preparing learners for emerging digital technologies. Using a case study approach, qualitative data was gathered through focus groups and one-on-one interviews. The findings revealed that many schools struggle to meet the demands of digital technology integration. Key challenges identified by teachers include limited institutional support, restricted access to technology, inadequate professional development, resistance to digital integration, lack of digital competence, low teacher motivation, security concerns, and policy gaps. By exploring the challenges of the South African schools, the Department of education and other curriculum specialists may learn about the complicated relationship between technological growth and the problems that need to be solved so that technology can be used to make the world a better place.

Keywords:

Challenges, 4IR, Technology hurdles, Integration, IoT, Robotics.

RESUMEN

En el siglo XXI, donde las cosas cambian constantemente, la tecnología es tanto una fuerza de progreso como un difícil obstáculo. La tecnología ha cambiado nuestras vidas de muchas maneras, desde la facilidad de uso de los smartphones y el Internet de las Cosas hasta el desarrollo de la IA y las herramientas educativas. Pero junto con estos asombrosos avances tecnológicos vienen un montón de problemas difíciles que deben resolverse antes que la tecnología pueda integrarse plenamente en las escuelas. Este estudio explora los retos a los que se enfrentan las escuelas sudafricanas a la hora de preparar a los alumnos para las tecnologías digitales emergentes. Utilizando un enfoque de estudio de casos, se recopilaron datos cualitativos a través de grupos de discusión y entrevistas individuales. Los resultados revelaron que muchas escuelas tienen dificultades para satisfacer las exigencias de la integración de la tecnología digital. Entre las principales dificultades señaladas por los profesores se encuentran el apoyo institucional limitado, el acceso restringido a la tecnología, el desarrollo profesional inadecuado, la resistencia a la integración digital, la falta de competencia digital, la escasa motivación de los profesores, los problemas de seguridad y las brechas en las políticas. Al explorar los retos de las escuelas sudafricanas, el Departamento de Educación y otros especialistas en planes de estudios pueden aprender sobre la complicada relación entre el crecimiento tecnológico y los problemas que hay que resolver para que la tecnología pueda utilizarse para hacer del mundo un lugar mejor.

Palabras clave:

Retos, 4IR, Obstáculos tecnológicos, Integración, IoT, Robótica.

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INTRODUCTION

The 4IR is characterised by innovations transforming all sectors of human activities, driven by the convergence of emerging technologies such as big data, analytics, cloud computing, AI, IoT, robotics, and virtual and augmented reality (Odewole et al., 2023) This changes the educational landscape of South Africa; thus, Ravendran et al.(2023) emphasised that teachers must lead the way in an incredible technology revolution. The Fourth Industrial Revolution (4IR) is expected to completely transform education by bringing digital innovation into classrooms and equipping learners for a world full of opportunities (Olifant et al., 2023). However, there are difficulties with this transition. Teachers in South Africa encounter a distinct set of challenges when attempting to incorporate advanced technology into their pedagogical approaches. The path towards adopting 4IR and digital transformation is both thrilling and intimidating, with obstacles ranging from inadequate infrastructure (Al-Maskari et al., 2022) to gaps in digital knowledge.

Although there is an expanding body of literature on the integration of 4th Industrial Revolution (4IR) technologies in education, there are still substantial research gaps, particularly concerning the distinctive obstacles encountered by South African educators. Most of the research is focused on developed countries, neglecting the unique socioeconomic and infrastructural contexts of South African institutions, particularly in rural areas. This is revealed in the research by Carrin (2022) in his research on students' readiness to use 4IR. He found that there is a lack of adequate recognition of the inequalities in the educational system, and the problems with customised curricula that 4IR assumes, which erode the possibilities of developing deep learning. This suggests that the standard of numeracy and literacy in South Africa, will not qualify learners to comprehend complex advanced 4IR demands. Consequently, inadequate investigations into the state of technological infrastructure and resource allocation, as well as a limited focus on teachers' experiences, attitudes, and requirements. Additionally, comprehensive policy analyses are scarce, and the extant professional development programs for enhancing the digital literacy of teachers have not been thoroughly evaluated. Additionally, the areas of cultural resistance and behavioral factors that influence technology adoption, as well as the impact of 4IR integration on student outcomes, are underexplored. To guarantee an equitable and effective digital transformation in education, it is imperative to address these gaps and develop effective strategies to assist South African instructors in adopting 4IR technologies.

This study is important because it may change South Africa's educational system by tackling the major obstacles teachers encounter in embracing digital transformation and the fourth industrial revolution (4IR). Giving educators the tools and abilities to incorporate digital solutions into their teaching practices is essential as technology and innovation drive the global economy more and more (Alshammari, 2024). This study intends to improve educational standards and student outcomes by identifying and eliminating technology hurdles, allowing for tailored learning experiences that increase engagement and effectiveness. It aims at empowering teachers by providing literature that ensures they are confident and competent in incorporating technology into their classrooms. The goal is to close the digital divide by solving infrastructure and access challenges, ensuring that all students have equitable access to current educational resources (Nkambule, 2023). This study also underlines the significance of integrating digital literacy and skills into the curriculum to better prepare students for the future employment market. The study's findings will help policymakers and educational leaders design investments and policies to support education's digital transition. Finally, by cultivating a tech-savvy workforce, the study hopes to increase South Africa's worldwide competitiveness and contribute to economic growth and development.

Technical infrastructure in South African schools

In the context of South Africa, the digital transition will have a great impact on how and what learners learn (Timmis & Muhuro, 2019). This suggests that teachers and the Department of Education should acknowledge the importance of digital innovation (Bertrand 2018) and the role of government in supporting digitization in education (Zulu 2019). Most developed countries, as explained, have adopted a specific policy strategy on digital education, in which they express their political view on the opportunities that digital innovation may bring to improve education (AUC/OECD, 2021), and on the challenges it may carry. Moreover, many made references to education as part of a generic strategy for digital innovation. In South African strategies, digitalization is often seen as a method to pursue other goals, notably economic growth (Moonsamy & Africa, 2020). Even though it is difficult to compare strategies individually, there are some outstanding similarities between them; to transform lives and drive economies (AUC/OECD 2021), to uplift learners' skills (Walling 2019), and teaching and learning purposes (Zulu 2019). It is important to note that the strategies do not reflect the state of the art of policy implementation within countries. Furthermore, in South Africa and other African countries, most of those strategies have no budget or implementation plan (Tawiah & Setlhodi 2020). This suggests

that the ideas put forward by many African countries may vary from work in progress to bold visions. The shutdown of schools after the COVID-19 pandemic has shown that South Africa still has a lot of work to do to integrate digital technologies into the education system (Lembani et al., 2020). However, those strategies present South Africa's views about the priorities, concerns, and opportunities of digitization in education.

In addition, digital education strategies for South African schools, rarely go into detail on specific technologies, digital content, and pedagogical approaches to assist teachers (Lembani et al., 2020). Instead, they focus on the functions of technology, which can be based on advances in existing technologies, on AI applications, or combinations of technologies. For instance, South African strategies mention the opportunities created by digital learning environments: digital platforms or portals of all kinds to help schools, teachers, and learners with their educational processes. The Department of Basic Education may focus on assessments, digital resources, or learning activities as examples. As data can be used to improve education and education policies, learning analytics and data management are often part of countries' strategies too (Moonsamy & Africa, 2020).

Digital education strategies focus mainly on the societal challenges that erupt from the digital transition and very little on professional and personal rationale (Timmis &Muhuro 2019). Thus, this research focused on the challenges that are specifically important for education. Skills and competencies take the most prominent place: the South African curriculum is committed to the education of learners for the 21st century and accordingly to the training of teachers (Zulu 2019). At the same time, South Africa addresses the importance of bridging digital divides and ensuring that every child can take advantage of digital education (Malinda et al., 2017). Another challenge that is mentioned in several digital education strategies internationally is the importance of data protection (privacy and security). However, South Africa is still in need of a strong IT and digital security body that will ensure that schools receive proper and legitimate information through the media. In addition, a major issue for almost all countries including South Africa, is ICT infrastructure (Murati and Ceka 2017), the availability of digital devices (computers, tablets), and internet connectivity. It turns out that digital education strategies in South Africa have an eye for the basics of digital education. Investments of all kinds and additional help for schools take a prominent place in strategies.

The focus of this study is to explore the unique obstacles encountered by South African teachers in the integration of digital transformation and 4th Industrial Revolution (4IR) technologies into their educational practices. This was achieved by answering the following research questions:

1. What is the current level of technical infrastructure in South African schools?
2. What are the factors that influence the adoption and incorporation of 4IR technologies in the classroom by South African teachers?
3. What are the perceptions of South African teachers regarding the benefits and challenges of integrating 4IR technologies into the classroom?

Research objectives:

1. To determine the current level of technical infrastructure in South African schools
2. To investigate factors that influence the adoption and incorporation of 4IR technologies in the classroom by South African teachers
3. To explore the perceptions of South African teachers regarding the benefits and challenges of integrating 4IR technologies into the classroom

This paper utilises both the elements of Vygotsky's social constructivism and Piaget's cognitive development. Vygotsky's social constructivism elucidates the learning processes that are influenced by social interaction through the use of three concepts: the Zone of Proximal Development (ZPD), inter-subjectivity, and enculturation. The ZPD refers to the distance between the actual developmental level, as determined by independent problem-solving, and the level of potential development, as determined through problem-solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978; Abtahi, 2018 & Breive, 2020). This implies that the teacher is unable to impart knowledge; rather, learners must acquire it independently. This further encourages learners to think critically, and creatively, experiment, solve, query, discover, evaluate, analyse, and present their knowledge in a variety of ways, all while adhering to the principles of constructivism (University of Buffalo, 2025). On the other hand, Piaget (1983) provides a useful theoretical foundation for incorporating Fourth Industrial Revolution (4IR) technologies into South African classrooms. By interacting with their surroundings, students actively create their understanding and knowledge, which is consistent with to use of 4IR technologies as catalysts rather than just tools to facilitate deeper learning experiences. Through active engagement with digital tools, computers, and the internet, students can experiment, explore, and apply information in meaningful ways. This method addresses the variety of educational demands and cultural contexts found in South Africa, supporting the notion that education should have a purpose and apply to students' daily

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lives. Furthermore, constructivism emphasizes the value of social interaction and teamwork in the learning process. It suggests that technologies that support peer learning, virtual teamwork, and collaborative projects can improve student engagement and foster the critical thinking abilities necessary to succeed in a technologically advanced world. Educators can customize technology integration tactics to enable students to actively create knowledge, solve real-world problems, and get ready for future difficulties in an increasingly digital society by embracing a constructivist perspective.

MATERIALS AND METHODS

This paper employs Interpretivism, a paradigm that emphasizes the subjective experiences and meanings of individuals. This paradigm is particularly beneficial in research that aims to investigate intricate social phenomena through a case study of 10 teachers, in this case, the obstacles that teachers encounter when implementing new technologies (Cohen et al., 2018). Furthermore, this paper adopts a qualitative approach, grounded in constructivist principles (AlShammari & Zaid, 2021), to explore the integration of Fourth Industrial Revolution (4IR) technologies in South African classrooms. South African teachers' 4IR technology adoption concerns are best studied using the interpretive paradigm, which allows for a comprehensive exploration of their complex, varied issues linked to personal, social, and institutional contexts. The interpretive approach gives deep, thorough insights into teachers' technological perceptions and attitudes by recording their subjective experiences, impacted by their backgrounds, training, and work environments. It also considers South Africa's educational variety by investigating how contextual factors affect instructors in diverse settings, yielding more relevant results. In-depth interviews and focus groups provide flexibility and depth, exposing underlying causes, motives, and barriers that quantitative assessments may miss. Policymakers, educational leaders, and technology providers can use teachers' own words to create practical, contextually relevant recommendations for interventions and support systems that meet South African teachers' needs.

Location, population, and sampling.

This research was in the KwaZulu-Natal province of South Africa which consisted of 11 districts: Zululand, King Cetshwayo, uMgungundlovu, Pinetown, uMkhanyakude, Umlazi, Ugu, uMzinyathi, uThukela, Harry Gwala, iLembe, and Amajuba. Each district has a different number of high schools. The target district for this research was Pinetown District, which consisted of four circuits: Mafukuzula-Gandhi, Umhlathuzana, Durban NorthWest, and Phoenix which all together count to 140 high schools. The targeted population for this research was teachers in high schools of the four circuits. The reason for choosing teachers from all circuits in Pinetown District was so that all circuits could be represented in this research for triangulation purposes. More specifically, high school teachers were the targeted population for this research because they are directly involved in preparing learners for the evolving 4IR work sectors. Pinetown district clusters have various quintiles (1-Rural, 2-Semi Rural, 3-Township, 4-Urban, 5-former Model C.). This allowed the researcher to purposely select two teachers for each quintile group (a total of 10 teachers were selected).

Data collection.

Data collection methods included semi-structured one-on-one interviews which were conducted on two teachers per quintile and focus groups (which took place online to gain access to all participants) to gather in-depth insights on experiences, perceptions, and challenges related to 4IR technology integration. The interviews duration was 45 minutes per participant to allow for in-depth exploration of 4IR technology integration.

Data analysis/discussions and ethical considerations

Thematic analysis, supported by a coding framework based on constructivist principles, was used to interpret patterns and themes within the data. Triangulation of findings from multiple sources enhanced the study's credibility (Cohen et al., 2018). Ethical considerations, including informed consent, confidentiality, and ethical approval, were strictly adhered to. Potential limitations such as sample bias and contextual factors were acknowledged. The study aimed to provide practical recommendations for educators, policymakers, and stakeholders to support the effective adoption of 4IR technologies and addressed identified challenges, contributing to enhanced educational practices and policies in South African schools.

This paper conducted focus group discussions and interviews with teachers from the schools involved in the study. Two subthemes have emerged from the qualitative data analysis. The first subtheme focused on factors influencing the adoption and incorporation of 4IR technologies in the classroom by South African teachers. The second subtheme focuses on factors influencing the principles of constructivism. The analysis of data in this chapter is presented with direct quotations from face-to-face interviews and focus group discussions of the study participants.

RESULTS AND DISCUSSIONS

Digital Preparedness Can be Demanding for Schools.

The qualitative data analysis shows that participants often stated that 4IR integration can make many demands

on schools, some of which are impossible to achieve. Some participants said their schools are not ready for 4IR. Schools require more basic supplies to run correctly. Some respondents said that teachers must receive computer and school administration training before they can be ready. Because some teachers are averse to change, the Department of Education must encourage them to attend advanced computer courses. Based on participant conversations, the researcher concluded that schools struggle with 4IR integration. Teachers also mentioned institutional support, access to technology, professional development, resistance to digital technology integration, digital technology competency, teacher motivation, security, and policy development.

Institutional Support.

Results indicated that schools do not give support to teachers as they try to engage with available resources at school. This suggests that some technology equipment that is available to schools is locked in storerooms and only certain individuals can access them. In some instances, the school management does not trust teachers with technology which hinders their integration during practice. A verbatim quotation confirms the latter:

"We are usually not allowed to enter the technology lab because they think we are going to damage them." (FGP1)

This suggests that even the manager of the school requires support and training for any technology available at the school. The school management team does not trust themselves in using technology tools, thus hindering the utilization of technology equipment in their schools. A similar view has also been shared by (FGP3)

"People who know computers at school, are not allowed to assist us." (FGP3)

FGP4 further elaborated that school principals have little or no knowledge of technology and are still not interested in getting digital technology lessons. Quotations further indicate that the school infrastructures themselves make it impossible for teachers to use technology tools in their classrooms:

"Our classes are very small and overcrowded. I can barely move from point A to point B. imagine holding a laptop, desktop, even a smartboard can be damaged." (FGP2)

It is also evident from the data that institutional politics hinder progress in schools. Teachers have lost hope, they just come in teach their subjects, and go home. This becomes a barrier to digital technology integration. There is not much focus on new things because of a lack of motivation from the teachers.

"The are lots of politics influencing my school, it could be teacher unions, fighting for positions and clicks. So, all that divides us and we cannot use available resources, especially if you are not one of them." (IP2)

The findings demonstrate that many schools have the availability of technology, but they do not receive enough support from their teachers to make use of such technological equipment. Participants have further made claims that they are not trusted anywhere near technology equipment since they might break or damage them. This suggests that school management teams do not have any idea of how technology tools work, so, through their lack of knowledge, fear of technology develops in them. This prevents technology tools and equipment from being used. While there is a fear of touching technology equipment, teachers who are competent in using computers are not allowed to train other teachers.

This suggests that if the school management team does not have strong digital technology confidence the schools will end up neglecting the use of digital technology completely. There will be a strong digital divide. Teachers lack motivation to try new things, in this case integrating technology into their teaching. In addition, participants elaborated that school principals have little or no knowledge of digital technology and are still not interested in getting digital technology lessons. Data further indicated that the school infrastructures themselves make it impossible for teachers to use technology tools in their classrooms. This suggests that teachers are not always the reasons for not integrating technology in school, but it's the government that is failing them.

Access to Technology.

Results indicated that participants do not have much access to technology that could assist them in digitally preparing matric learners for higher learning institutions. Although some participants indicated that they have computer laboratories, participants indicated that they are not sufficient to fully embrace 4IR. Having a smartboard alone without learner laptops is making it harder to fully integrate technology into teaching. Teachers are not allowed to access computer laboratories in schools because laboratories are reserved for learners specialising in computer subjects. And in many cases, computer specialising learners constitute almost 20% of the school's population. Evidence has been demonstrated by quotations:

"In my school, we just have the computer Lab for IT and CAT we cannot go there but the subject teacher only" (FGP2)

Similarly, participant IP2 said that multimedia centers are for certain individuals in the school.

"We have 3 laboratories for computers, and certain classes that have smartboards and are called multimedia centers. But not all teachers go there, I hardly go there myself." (IP1)

Participants have also indicated that technological equipment is locked in storerooms, which is why they cannot access it. Sometimes they are never used until reported missing:

"Management does not talk about what is in the storerooms." (FGP4)

A similar view was indicated by a participant who stated that they see sponsors donating electronic gadgets, but those gadgets remain in storerooms:

"My school got a donation of 10 smart TVs and mobile computer hubs containing 30 laptops. They were kept in the storeroom since 2014 until now I do not even know if they are still there."

Some participants had different claims that concerned the use of space. That hinders them from accessing technology devices:

"Our classes are overcrowded, so, technology equipment cannot even enter our classrooms." (FGP1)

A positive response by a participant indicated that they do not have any problems accessing technology in their classrooms. This indicates a structured management of technology resources to assist teaching and learners for effective teaching and learning to take place.

"I do not have any problems accessing digital technology resources in my school. We use them all the time, resources are always in my classroom." (FGP3)

On the one hand, other participants indicated disorganisation on the side of the school management. This causes the resource to be out of reach of the teacher. Furthermore, teachers can easily be demotivated to access resources because of disappointments.

"With us it is different, we have to schedule to go to the multipurpose center where all computer resources are. It becomes chaotic at times because you find that many teachers are occupying it with their learners. You end up not getting the slot." (FGP6) A few participants mentioned computer laboratories; however, they contend that they were inadequate for the integration of 4IR. Consequently, the integration of technology into the classroom is impeded by the absence of student laptops and the use of a smartboard. Teachers are unable to use computer laboratories, as they are exclusively designed for CAT/IT learners. The school has a low number of learners who specialize in CAT/IT. They are unable to access technical equipment that is secured in storerooms. Occasionally, they are not used until they are reported missing. Classes that were overcrowded were the subject of numerous complaints from participants. This impedes the utilization of technology. Some participants reported that they have no difficulty using technology in the classroom. This suggests the importance of structured technological resource management to facilitate the process of instruction and learning. According to certain participants, the school administration was disorganized. Consequently, the resource is unavailable to the teacher. Additionally, instructors may be discouraged from obtaining resources due to disappointments.

Professional Development

The responses of participants in this section indicate that one of the challenges facing teaching with integrating 4IR is the absence of training support and staff development programs. The researcher learned during the transcription process that participants frequently made comments indicating that staff development and training programs for digital technology integration are insufficient. Some participants disclosed that they had never participated in any staff development programs or received any kind of technological training. These participants' comments revealed a sense that the difficulties with technology integration in secondary schools were a result of a lack of staff development and training support (Sellami et al., 2024). Among the participants, one from a one-on-one interview said:

"No teacher workshops for digital technology were ever proposed to us." (IP1)

On one hand, one participant suggests that the Department of Education should have on-site support for teachers so that they can be assisted with the correct way of integrating technology into their teaching:

"There should be onsite support for teachers as they use technology" (IP3)

Research findings have also indicated that workshop facilitators have no idea about digital technology. This suggests that a train-the-trainer workshop is necessary for teacher development workshop facilitators to be given competent skills in digital technology.

"The workshop facilitators do not know much about digital technology. Teachers teach themselves over time until they get used to it. That is why it will take longer." (IP4)

In addition, some participants observed that in their school they have good digital technology resources, but they cannot use them. This suggests that professional development is very crucial for digitally preparing matric learners for higher learning institutions.

"We do have digital tech. resources, but we cannot use them." (FGP2)

According to findings, a lack of training support and staff development programs is one of the hurdles teachers encounter in integrating 4IR. During transcription, the researcher found that participants frequently emphasized staff development and digital technology integration training. Participants indicated that they had never taken staff development or technological training. These comments suggested that secondary school technology integration issues were caused by a lack of staff development and training.

Additionally, some participants suggested that the Department of Education must provide on-site support for instructors to help them integrate technology into their lessons. This shows that a school's culture must be developed before 4IR is fully embraced. Research also shows workshop facilitators lack digital technology knowledge. This shows that teacher development workshop facilitators need a train-the-trainer workshop to learn the complex knowledge of 4IR.

Resistance to Digital Technology Integration.

In this section, participants argued that they have no time to integrate technology into their teaching. Some of them argued that it was a waste of time, they needed to complete the subject syllabus. They have also alluded that technology is a distraction to learners because it makes them lose focus in class. This suggests that teachers have not found a proper way of integrating technology in their teaching (Sapir, 2024), which results in them disliking technology. They therefore miss a great opportunity for the benefits of 4IR. Quotations for participants state the following:

"It wastes my time; I cannot finish my syllabus." (FGP1)

Some participants mentioned that they just use their laptops for typing exam papers and not necessarily for teaching learners. The findings suggest that teachers do not have the zeal to learn more about how to explore the use of their current gadgets to integrate technology into their teaching.

"If you as a teacher have a laptop, there is nothing much you can do besides getting your paperwork typed but not for learners because there is no Wi-Fi in my school." (FGP2)

A similar indication was alluded to by a participant who stated that their school has most digital resources, but they are not being used. In many schools, many teachers have never received any digital technology training, but because resources are present, they try to teach themselves until they get used to them. Although it will be a slow process, eventually they learn. The traditional ways of teaching suggest that teachers are just so comfortable in their tradition, and they resist the change that is taking place:

"My school received projectors and laptops per teacher, but we are still using the traditional way of teaching because we are not trained to use them" (FGP4)

Since using digital technology resources in the classroom requires effort, participants indicated that they would rather have someone assigned to bring the resources to their classroom from the storeroom than pick them up themselves. If the school does not cater to that, they will not use digital technology in their classrooms. This suggests that digital technology resources will stay in the storerooms unused, hence, it is not in the teachers' interest. This suggests that teachers tend to not emphasise what they do not accept, especially if it is bringing change to the status quo. Evidence is shown in a quotation:

"There is nobody bringing resources to us, so I do not have to time for it, but I am aware that we have digital devices. I am at school to teach Mathematics and that's it." (FGP3)

Similar views were uttered by participants that they would not account for any digital technology resources:

"When I collect them from the storeroom, I must account, and I hate that. So, I would rather not use them." (FGP5)

Some participants are so attached to their subject, only to miss the opportunity to integrate technology:

"English does not have much need for digital technology, so I do not bother." (FGP6)

Participants indicated that they did not have time to teach with technology. Some said it was a waste of time because they needed to finish the syllabus. They also argue that technology distracts students in class. The lack of an effective strategy to integrate technology into teaching shows that teachers oppose it. Thus, missing out on a wonderful opportunity of embracing 4IR. Some participants said they merely type exam papers on their laptops, not teach. This shows teachers are unmotivated to learn how to use their technology.

Participants said they would rather have someone deliver digital technology supplies from the storeroom to their classroom than pick them up because it takes effort. Without this, pupils cannot use digital devices in class. This means technological tools in storerooms will be underused. This shows teachers are unconcerned with what they reject, especially if it challenges the established quo. Participants said they would not account for digital technology resources. Some participants are too concentrated on their subjects to use technology. Some teachers attended digital technology integration training for a long time, indicating that the department is trying. Participants also reported that teachers refuse to learn new skills, even

if they are needed. They prefer to find weaknesses in the new demand to avoid responsibility.

Digital Competence and Motivation

The data has shown that when teachers are not competent enough in digital technology, they tend to get demotivated. However, those with good computer skills are always excited about integrating computers into their teaching. This section has indicated that there is a very small number of participants who had a deeper knowledge of digital technology in the sense of integrating it with their teaching practice (Korhonen et al., 2024). Most participants viewed 4IR knowledge (big data, analytics, cloud computing, AI, IoT, robotics, and virtual and augmented reality) as a subject on its own (CAT, IT, and Computer literacy). Participants were asked the following question: how would you define 4IR? These are some of the responses:

"Knowledge of a computer" (FGP1)

"Teaching learner's computers" (FGP2)

Participant FGP1 referred to digital technology as his knowledge of computers, while Participant FGP2 referred to digital technology as the teaching of learning digital technology. The latter distinction of digital technology does not put any of the participants on the wrong side but highlights the different views of participants on digital technology. This emphasizes the importance of teachers' knowledge of 4IR before even imparting it to learners. This impacts how they integrate digital technology knowledge into their teaching practice.

Some participants referred to digital technology as tools and the internet. This does not give sufficient to the proper knowledge of digital technology. Participants could have expanded on the connection of the tools with their pedagogical approaches. Participants' responses could easily be referred to what they see every day in the computer laboratory, and that becomes what they define as digital technology knowledge. The responses are average and do not put them into a computer-competent category.

"Smartboards, desktop and laptops" (FGP3)

"Anything to do with Technology-Smartboards and desktops. Well, I am not very sure; I was not trained for it" (IP3)

"Internet" (FGP4)

Participants FGP4 and IP2 defined digital technology knowledge that is more related to pedagogical practices. This referral to digital technology shows that they are already integrating digital technology into their teaching.

"Online teaching platforms" (FGP5)

"Knowledge of problem-solving skills through technological approach." (IP2)

Some participants mentioned that their schools are completely neglected concerning digital technology knowledge because of their locations. This suggests that South Africa is experiencing a massive digital divide, which is making it difficult for schools in rural areas to digitally prepare matric learners for higher learning institutions.

"My School is in a rural area, it's the first time I have even heard of the word open learning system. Well, social media I use WhatsApp but not with learners because most of them have no cell phones." (IP1)

Teachers become demotivated when they lack digital technology skills. Good computer users are excited to use computers in their instruction. Only a few participants had a deeper understanding of digital technology and how to integrate it into their teaching. Most participants saw digital technology as a separate subject (CAT, IT, and computer literacy). Some participants defined digital technology as their computer expertise, whereas others defined it as teaching and learning tools. The latter distinction of digital technology acknowledges the participants' different views on it, not placing them on the wrong side. This emphasises the need of teachers knowing and using digital technologies before teaching learners.

Security

In this section, participants mentioned that schools are not a safe place to keep digital technology devices. Even the teachers who are using the devices are not safe because they get robbed in school facilities. Participants have further indicated that learners also are not safe with technology devices as they leave the school. Participants also argued that even the school management can be involved in the theft of technology devices that are donated to schools. This suggests that digital technology devices put schools at risk of getting robbed:

"There is no sufficient security at our school to keep digital devices." (FGP1)

"Computers get stolen in our area, even the one laptop at my principal's office got stolen, the school is not even fenced." (IP1)

Another view raised by participants is that digital devices can go missing in schools without any break-in. This implies that teachers and other staff members in the school could be stealing digital devices.

"My school got a donation of laptops, they all went missing, but there was no break-in." (FGP1)

Similar claims are made by a participant that it is the school management that could be taken from the school's resources.

"With us It's the principal and his people, we do not even know whether he sells them or not." (FGP3)

Some participants argued that they have already discontinued digital technology for the safety of the school. This suggests that many failures in digital technology integration are caused by inadequate school security.

"There have been 4 break-ins in one year at our school, so we even discontinued the computer subjects." (FGP2)

Some participants flagged another security risk, and this is a software risk. When computers have too many viruses, they become a threat to the data of the school. This security risk requires that the school get an onsite technician who would constantly maintain digital technology devices and software.

"Our computers are all infected by viruses, our lab is a no-go area, very infected." (FGP4)

Some participants argued that there is a security risk for teachers as they have digital technology devices. Learners are ill-disciplined, they can easily steal from teachers, and this is due to poor security in schools.

"Teachers are not safe at my school, once you have a smart gadget as a teacher, learners would steal it. If not current learners, its former learners, they come into our school point guns at us in the staffroom and take our laptops and cell phones." (FGP5)

Three respondents said schools are unsafe for digital gadgets. School facilities are looted, making even device-using instructors susceptible. Participants also reported that learners' digital devices are unsafe after school. Participants also stated that school management can steal donated tech. This implies that digital technology devices increase school robbery risk. Student safety is also compromised by their electronic devices. Criminals target them. Students lose digital privilege when learning to use digital technology gadgets becomes challenging (Severinsson, 2023). Participants also thought schools could lose digital devices without a break-in. Teachers and staff may be taking school electronics, according to the findings. Participants said they stopped using digital technologies for school safety. This implies that weak school security causes many digital technology integration failures. Participants also noted software security risks. Computers with too many viruses threaten school data. The school must engage an onsite technician to maintain digital technology device software due to this security concern. Digital technology gadgets pose a security danger for teachers, according to some participants. Disobedient students can steal from teachers due to poor school security.

Discussion of the findings

The research questions, theoretical framework, and objectives were all successfully included in this research (Cohen et al., 2018; Johnson & Onwnegbuzie, 2004; Creswell, 2014). The unique obstacles encountered by South African teachers in the integration of digital transformation and 4th Industrial Revolution (4IR) technologies into their educational practices were explored through a case study of 10 teachers. Qualitative data from 10 teachers was used to explore the pedagogical approaches of matric teachers in digitally preparing matric learners for higher learning institutions. This was done through interviews and focus groups because there had been a dearth of research in the latter field. Hence, this research was able to answer the three research questions by giving a comprehensive explanation of the data collected from the teachers.

Furthermore, this study uncovered several previously underexplored insights into the challenges South African teachers face in integrating 4IR technologies into education. While global discussions often focus on general digital transformation barriers, this research highlights context-specific challenges, particularly the unequal access to infrastructure across different school quintiles (Carrim, 2022). A significant finding is that limited institutional support, including inadequate funding, weak ICT policies, and lack of leadership commitment (Bertrand, 2018), plays a crucial role in hindering technology integration. Additionally, teacher resistance to digital adoption is not solely due to a lack of skills but is also driven by fears of job insecurity, increased workload, and concerns over student engagement and discipline in digital learning environments. The study further reveals gaps in professional development, as many existing training programs fail to provide hands-on experience with emerging technologies like artificial intelligence (Olifant et al., 2023), robotics, and IoT. Another overlooked challenge is cybersecurity, with teachers expressing concerns over data privacy and online threats (Tawiah & Setlhodi, 2020). Moreover, despite national policies promoting digital transformation, many schools struggle to translate these policies into practical implementation due to inadequate infrastructure and guidance. Finally, teacher motivation plays a crucial role in digital adoption, with schools that have strong leadership and incentives demonstrating higher success in integrating technology. These insights emphasize the complexity of digital transformation in education and highlight the need for targeted, context-aware interventions.

Recommendations

Based on the findings of this study, the following recommendations may address the challenges faced by South African teachers in integrating 4IR technologies into teaching:

- Enhance Institutional Support
- Improve Access to Technology
- Strengthening Teacher Training and Professional Development
- Develop Clear Policies and Guidelines
- Encourage Positive Mindset Toward Digital Integration
- Increase Cybersecurity Awareness and Measures
- Foster Collaboration Between Schools and Tech Industry
- Incorporate Digital Skills into the Curriculum
- Monitor and Evaluate Digital Integration Efforts

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