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Preparing Grade 9 technology learners for the terrain of the fourth industrial revolution

Ngcobo, Zime

2024

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Preparing Grade 9 Technology Learners for the Terrain of the Fourth Industrial Revolution

Student: Zime Ngcobo (1533396)

A research by dissertation submitted in conformity with the requirements for the degree of Master of Education Degree

Department of Educational, Information and Engineering Technology
Wits School of Education
The University of the Witwatersrand

Supervisor: Dr Alton Dewa

Date: May 2023

Declaration

I, Zime Ngcobo, hereby declare that this project has not been previously submitted for a degree nor has it been submitted as part of the requirements for a degree. I also certify that the project has been written by me. Any help that I have received in my research work and the preparation of the project itself has been acknowledged. In addition, I certify that all information sources and literatures used are indicated in this piece.



May 2023

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Abstract

The fourth industrial revolution (4IR) represents a complete shift from manual and conventional methods of operation to a more computerized one. It is crucial to get ready for this environment so that civilization can survive and manage it throughout this period. The goal of this research was to find out if technology students in grade 9 are being adequately prepared for the 4IR environment. The study examined the pedagogies, subject-matter expertise, and 4IR knowledge that potential grade 9 technology teachers may possess to achieve this goal. Due to the nature of the focus of the study, it remains important to target individuals who are relevant to the study and may contribute relevant findings, purpose sampling was done, hence, only well experienced Grade 9 Technology teachers were requested to participate. Five South African public schools in Gauteng province participated in the study. In these five South African public schools, only grade 9 Technology teachers were requested to participate. Learners did not form part of the research as the research dwells much on the teaching strategies and type of content presented in the classroom. Data was collected using interviews through Google Meets virtual platform with ten Technology teachers in grade 9. The study is qualitative and used a case study. The conceptual framework for the development of 4IR skills, which was modified from (Kamaruzaman, Hamid, Mutalib & Rasul, 2019), served as the basis for the data analysis. The data analysis approach of this study was entirely based on inductive reasoning as all the findings and conclusions were based on evident information. The link between educational institutions, graduates, and workplaces was explained in detail and in broad strokes by this paradigm. This demonstrates how crucial it is for the educational system to deliver high-quality instruction that is compatible with the demands of the 4IR workplace. The 4IR skills are anticipated to be taught through the educational system utilizing digital tools and effective pedagogies. The research revealed that the majority of technology educators in public schools lacked adequate digital teaching and learning resources, which impede them from using digital technology-driven instruction in the classroom. This further prevent students from using digital resources to acquire 4IR skills like digital fluency. Participants also mentioned that the majority of them lacked digital technology abilities and were unable to use these educational tools because of this. Participants are thus unable to get learners ready for the 4IR. Learning the skills required for the 4IR workplace are being hampered by learners' lack of exposure to digital technology. Some participants also expressed their lack of familiarity with the 4IR. They are unaware of and do not think that 4IR is a possibility. Because of this, it is impossible to prepare students for this period. To ensure for protection and reliability of the study,

ethical procedures were followed according to the expectations of the university. Personal information of all the participants was protected at all times.

Key words: Fourth Industrial Revolution, Digital technology, design process, instruction, Artificial Intelligence

Acknowledgement

This work would have not been possible without the strength and great guidance from The Almighty God. I thank You. Thank you for instilling wisdom and the spirit of hard work in me. It is through You that I have reached this point.

I cannot express enough thanks and gratitude to my supervisor, Dr Alton Dewa, who guided me throughout this project. Thank you for your patience and consistency in terms of encouragement and pushing me to complete this project. Thank you for your wise words and advises on this project.

To my parents, Lucky and Ntombifuthi Ngcobo, my sisters, Noxolo, Ntathu and Ngimphiwe, and my brothers, Nsizwa and Sesiyabonga. I would not have done this without you. Thank you for believing in me. You are responsible for all the success I have achieved. I can never thank you enough. I dedicate this dissertation to you.

Lastly, but not least, I would like to pass my gratitude to the National Research Foundation Bursary for offering me with this opportunity.

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List of Acronyms

4IR	The Fourth Industrial Revolution
AI	Artificial Intelligence
ICT	Information Communication Technology
CAPS	Curriculum Assessment Policy Statements
GDP	Gross Domestic Product
STEM	Science, Engineering, Technological and Mechanical skills
1IR	First Industrial Revolution
2IR	Second Industrial Revolution
3IR	Third Industrial Revolution
IR	Industrial Revolution
GgET	General Education Trainin

Chapter One: Background of the study

1.1. Introduction

The upcoming era known as The Fourth Industrial Revolution (4IR) is technology centered and mostly associated with artificial intelligence (AI). According to Perret, Johnson, McCarthy, Guerrero, Dai & McNamara (2017) AI is the science and the application of computer-based intelligent machines invented to meet human needs. It is of paramount importance that society stays prepared for this industrial revolution to be accommodated so as to ensure that competent and capable citizens are produced to fit in as part of the workforce. As the medium of transforming society, the education system is required to restructure itself by including skills and knowledge of the 4IR. This means, teachers' pedagogies need to integrate resources such as technology devices in their teaching and promote them so that learners become familiar with resources that will assist them acquire skills needed by the 4IR.

Technology is an application of scientific, processed knowledge into the real world, to contribute to human life. This is alluded to by McCarthy& Wright (2004) as they perceive technology as an experience, rather than just a phenomenon that involves the use of digital tools and the Information Communication Technology (ICT). This suggests that technology is the use of tools to meet human needs through its effective use, rather than just studying and interpreting the natural world. In South African Public basic education, technology is offered as a subject (from grade 4-9) that intends to tackle specific processes of human life, such as mechanics, electronics, etc. According to the Curriculum Assessment Policy Statements (CAPS) (2011), technology was introduced and implemented to produce a technology literate society. Furthermore, this subject aims to bring about knowledge on careers that are mostly attached to it, such as architect, engineering, artesian, just to name a few. It is noteworthy that this technology subject exists to emancipate human life in society, including industries. This is because it is through the development of technological skills and values that human needs are met. For instance, human needs such as navigating through society, having access to digital articles and communicating with people who may be located in scattered places. Consequently, this goes hand- in- hand with problem-solving as well as considering social and environmental factors.

Occasionally, economic and social aspects are said to advance and evolve with a major aim of developing the country. Human needs are met with modifying approaches that are derived from the standard state of the world's economy. This is significant as it maintains the economy of the country, especially when in partnership with the external world and expected to meet a certain

standard. This phenomenon is regarded as an industrial revolution. Hudson (2014) argues that, although the modifier ‘industrial’ is outmoded, it does not only include manufacturing or heavy industries, but is an industrial revolution that also changes human conditions as per specific needs to be met. Moll (2021) claims that, for a period of change to be regarded as a revolution, it should be characterized by a long-term socioeconomic change in some instances. For example, the extent to which a country's average income is able to sustain the Gross Domestic Product (GDP) determines if the industrial revolution is paramount to maintain the economy of the country.

Skilton & Hovsepian (2018) describes the 4IR as the peak at which automated technologies are entirely used in the physical and biological worlds. The 4IR is aimed at developing the country's economy by incorporating advanced technological resources with knowledge. According to Naudé (2017), "If Africa is to industrialize in future it will have to do so in a 4IR wherein new technologies such as automation, additive manufacturing and the industrial internet, are changing the essential nature of production and consumption." The term 'changing’, suggests that all procedures and methods considered to be "normal" totally evolve, to accommodate expectations of the 4IR. Before 1860, as Butler-Adam (2018) states, most parts of South Africa electricity came second as it was not required for industrial processes as they were mostly traditional and done manually. However, at present this has changed. Most South African industrial and business sectors use electricity, and most activities in industries, such as digital computing, require electricity to operate. This is evidence that shows the actual evolution that occurs and caters for human needs. Big data, model simulation, cloud technology, augmented reality, 3D printers and additive manufacturing, the Industrial Internet of Things (IIoT), artificial intelligence, autonomous robots, and cyber security make up the core elements or framework of Industry 4.0.

In a South African public-school context, Grade 9 Technology teachers make use of textbooks and other visuals (such as charts and models) as teaching aids when teaching. Yet, these teaching methods do not align with the skills required for the 4IR. Tsekeris (2019) mentions characteristics such as being digitally literate, possessing computational thinking, critical thinking skills, etc. as those suitable for the 4IR. What is more, it is these characteristics that are believed to be technology centered. According to the study of Tsekeris (2019), the expected knowledge in the 4IR include information, media, and technology skills which constitute a strong and integral part of the new framework for the twenty-first-century learning paradigm, a case that is lacking among grade 9 technology teachers.

1.2. Problem Statement

Technology integration in the learning and teaching in classrooms is faulty. This suggests that the teaching practice is intermittent, occurring at irregular intervals rather than being consistent. Mtshali, Ramaligela & Makgato (2020) claim little attention has been paid to making these digital tools available as well as its utilization in technology subject classrooms. The lack of technology-equipped classrooms has caused a tardy adoption of digital tool integration in teaching practice, which has badly impacted learning by depriving technology Grade 9learners of access to digital-centered education, which is envisaged to equip and prepare them for the 4IR workplace. The 4IR workplace is mostly associated with digitals and the online world. It is the advanced version of the current way of doing things. Yet, according to Philbeck & Davis (2018, pg. 17), "the fourth industrial revolution (4IR) is an entire emergence of technologies on the gamut of human development. It is a technological transformation to all industries and all parts of the society". This failure to integrate ICT tools with teachers pedagogic practice follows deprive learners of an opportunity to get prepared for the 4IR workplace. The teachers of Technology subject in Grade 9 are at a quandary for how to introduce learners to the competencies and expectations of the 4IR due to a shortage of digital-technology resources and their own lack of expertise. Another scholar, Nhede (2018) agrees and emphasizes the need for society to acquire necessary skills for the 4IR workplace such as to operate the machinery to and improve the quality of goods and services rendered to the public. In other words, technical and Science, Engineering, Technological and Mechanical (STEM) skills are of paramount importance in the 4IR, and these skills can only be obtained through the educational route.

1.3. Aim of the Study

The term "4IR" was first used by Schwab (2017) to describe a period of time that is anticipated to be dominated by automated and digitalized processes. There is no little doubt that this period will bring about change and development in all facets of society, particularly in the workplace. It is important to get ready for this age because its skills and knowledge may differ from those currently in use. The educational sector is crucial in reshaping and improving society, and it is the key to change. This is because teachings and practices implemented in educational institutions affect, or rather shape an individual's consciousness. It is able to modify the society's way of doing and seeing things. Idris, Hassan, Ya'acob, Gill & Awal (2012) describe education as the milestone of the society's development as it is capable of introducing and installing necessary knowledge to the society, thus equipping and shaping it. In this case of the upcoming 4IR, it is up to practitioners and educational specialists to figure out how to get people ready for

the 4IR. The study's goal is to determine ways in which Grade 9 technology teachers can equip their learners with the skills needed for the 4IR space.

Given the transition from one industrial revolution to the next, changes in skills and knowledge are required, as processes will no longer be competent. With the goal of implementing and introducing new methods, teaching methods and resources may be impacted. The study also concentrated on evolving trends brought about by digital technologies that are causing radical changes in the educational sector, as well as how these changes should be incorporated to propel learners to the skills required by the 4IR and the future of work.

1.4. Research Question

How do Grade 9 technology teachers prepare learners for the 4IR in their teaching practice?

1.4.1. Research sub questions

- What methods of teaching do technology teachers practice, that prepare learners for the 4IR?
- What are the 4IR skills that technology teachers should impart to learners?
- What digital technological gap (knowledge and skills) do technology teachers have when using digital tools that may prepare learners to meet the needs of the 4IR?
- How do technology teachers envision ideal ways of preparing learners for the 4IR terrain?

1.5. Significance of the study

This study investigates how well Grade 9 technology students are prepared for the 4IR terrain. The 4IR landscape anticipates a young generation with required digital abilities, such as computational thinking, digital fluency, and virtual cooperation to mention a few. The importance of this research is that it will benefit practicing teachers, particularly those that are in the field of Technology subject, by providing them an insight into teaching methods and how appropriate resources can be used in their classroom. The awareness and knowledge that educational pedagogues may have regarding appropriate teaching tools and methods will be a further success in terms of preparing learners for the 4IR terrain.

Additionally, this will motivate those working in the field of education to create and rethink new potential implementations of digital-technological integration pedagogic approaches and appropriate resources for teaching technology in Grade 9 in order to successfully prepare students for the 4IR landscape. A change from manual teaching resources and methods to more

digitalized and 4IR-focused practices will be made possible by this, allowing those working in the field of education to propose policies, theories, practices, etc.

This study will further educate Grade 9 technology teachers about the significance of preparing students for the 4IR environment by providing them with the knowledge and skills they need. This is because employers may favor 4IR capabilities in the job, necessitating that one be fully prepared with those skills. Individuals might find it simpler and more feasible to integrate into the 4IR environment if they have the requisite abilities in this way.

Chapter 2: Literature Review

2.1. Introduction

The phrase "industrial revolution" describes a change that could occur not just in certain industries but also in society as a whole. This is the process of improving and developing existing procedures with the goal of raising the level of living. According to Rani, Kataria, & Chauhan (2022) the industrial revolution forced required changes in both the literature and industries, which may have had a significant positive impact on society and human work. The obvious pattern that can be identified in the industrial revolution seeks to bring change and improvement to the society.

By considering the shift from one industrial revolution to another, this chapter reviews the technology and skill requirements for the 4IR as well as studies conducted by various authority in those fields. This chapter gives a critical synthesis of empirical literature in accordance with pertinent themes or variables and explains how this study tackles a gap between pre-4IR skills and processes and navigating through the 4IR as the research problem has been clearly defined.

The conceptual framework of the study developed by Kamaruzaman, Hamid, Mutalib & Rasul (2019) is also described in this body of literature. It is based on the significance of information and skills presented by educational institutions in the outside world and the workplace. It presents the background to the study which is derived from the research question: *What pedagogical practices do technology teachers exhibit in their teaching that prepare learners for the 4IR?*.

This chapter will outline key areas that to be reviewed in order to achieve the study's goal as follows:

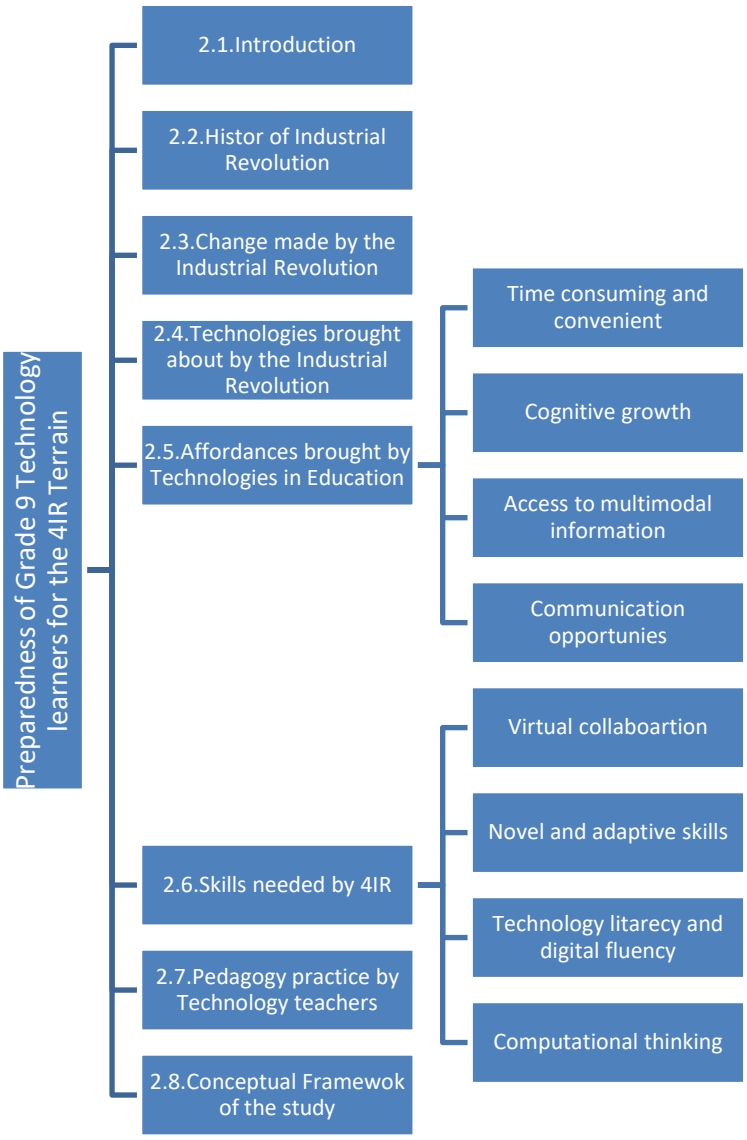


Figure 1: Literature review outline

2.2. History of Industrial Revolution

It is an undeniable fact that the growth of the population affects the standard of living and thus, demands more production to take place. According to Lucas (2002), it was discovered that the world's population growth over the 40 years, from 1960 through 2000, has occurred at an annual rate of 1.7 per cent, and as result, available resources get outstripped. As a result, this becomes the main cause of poverty and starvation. However, it is without a doubt that the proportionality in the rate of production to the growth of population withstands the standard of living. The extent to which goods and services are being produced should be in correspondence with the population.

Hunt (2011) describes the study of history in general as of necessity, as at this current point, the dominating phenomenon of Technology, or rather ICT, is very much relevant and it is necessary that it be known. This is because as society is constantly evolving, it revolves, and technologies

are being introduced along the way and this influences the main goal of developing society. The technological perspective of society today may or may not be advanced to satisfaction, it is merely based on its history as it best makes sense of the current situation.

Hudson (2014) refers to the industrial revolution as a period that offers an integrated account of an economic and social aspect of change. Concurrently, Stearns (2020) describes the industrial revolution as a phenomenon that has changed the world and continues to shape the contemporary world. This suggests that an industrial revolution is a recurring event that occurs periodically, as development and change need to be implemented to sustain and enhance the growth of the country's economy.

As per the history of the industrial revolution, the purpose of inventing it was entirely based on industrializing and urbanizing societies. One would try and imagine how life would be without something as important as electricity. Even though life would be possible as it was before the industrial revolution, however, processes and procedures in the society would not be as effective, efficient and productive as it is now.

The industrial revolution does bring positive change in the community, in terms of growing the economy, and so on, however it also installs a negative effect in the society. Rani, Kataria & Chauhan (2022) mentions that it is important for industrial revolution to take place in the society however it may bring about negative impacts that could be a threat to individuals' living and their society. Human labor is essential in most industries, and it is through human labor that most families, particularly black families, are able to sustain their lives. The introduction of new resources with the goal of "industrializing" society may have a severe impact on these families. This is due to the fact that hard labor may no longer be prioritized, resulting in unemployment.

Another factor could be that of lack of skills and knowledge of certain work aspects. Individuals that were exposed to quality education may stand a good chance in navigating through a newly introduced industrial revolution era. In Wagner's book that was published in 2010, the idea lies on observations based on the necessity of pupils to be equipped with necessary knowledge to survive in the society. At this current time, it is well known and is a norm that South African private schools serve better and quality education, compared to public schools. This is merely because pupils in South African private schools pay a lot of money for their education, in that way, their schools are well resources, thus serving quality education and acquire relevant and necessary skills and knowledge. This automatically differentiate individuals in the society into

classes, and give those that are well equipped an opportunity of work successfully in the workplace. It is well known that inequality in most societies takes place, the ongoing shift from one industrial revolution to another makes it too obvious.

Moll (2021) argues that, though industrial revolution is brought about to improve the standard of living and benefit the society, it also its own drawbacks. According to him, the industrial revolution was the catalyst for the development of capitalism. Undoubtedly, the industrial revolution has improved the economy, but it has also further repressed people who are used as laborers and benefited the elites. Williams (1994) described a case of slavery funding that took place in Britain in the 17th century, where Negros were used to create new industries in England but received little in return for their labor aside from some plantations and other resources that could support their families, forcing them to return to work the next day. Production costs and prices sharply decreased as productivity rose steadily.

Some of the processes brought about by the industrial revolution may be seen as bringing convenience, but they may not meet all of the ends. Walking miles to get necessities may be viewed as a disadvantage; however, modes of transportation such as trains and cars may be more convenient, but they harm the ecosystem by emitting harmful gases. Another factor could be the implementation of products that use natural resources such as trees and may harm the ecosystem.

In a nutshell, the industrial revolution was crucial to the development of the nation's economy since it helped the nation connect with and cooperate with other industrialized nations, raising living standards in the process. It is also contradictory because it has unfavorable effects that could repress people who are underequipped and endanger the existence of living things and their surroundings. For example, according to Rymarczyk (2020) the introduction of autonomous vehicles brought so much convenience to a lot of societies, however will contribute to air pollution and climate change which may become an advantage to the society.

2.3. Changes made by the Industrial Revolution.

Agriculture was the cornerstone of South Africa's economy before the Industrial Revolution. Rich landowners would rent out their property to farmers, who would then cultivate and market crops. This transaction played a major role in how the economy functioned. People started abandoning their fields and moving to the cities to work as a result of the changes brought about by the Industrial Revolution. People were forced into factories by the new technologies, which marked the beginning of a capitalistic way of life. Due to the revolution, the bourgeoisie gained economic power at the expense of the aristocratic people (the middle class).

Table 1: A Summary of Industrial Revolutions

Period	Revolution	Main technical/Industrial achievement
1760-1900	1 ..... 	Steam Engine Textile, Steel, mechanical production equipment
1900-1960	II.... . ..... 	Internal combustion engine, electricity, mass production Metallurgy, Auto, Machine Building
1960-2000	III ..... 	Computers, Robots, electronics, IT Auto, Chemistry
2000.....	IV ..... 	Internet, 3D Printer, Genetic Engineering High Tech industries, Cyber-physical systems

Adapted from, Prisecaru, (2016).

Schwab (2017) views the 18th century as the century of drastic change, that he refers to as the industrial revolution. The first industrial revolution (1IR) took place towards the end of the eighteenth century and arose to maintain the country's economy in terms of manufacturing and producing goods and services. Penprase (2018) mentions that this so-called 1IR occurred by harnessing water and steam power towards more systematic and efficient forms of manufacturing. As the expansion of the global economy took place, the shift from the 1IR became a necessity.

New technological marvels were innovated amid the Second Industrial Revolution (2IR). This includes the manufacturing of electricity-based technologies which triggered additional changes, thus launching the new economy. The 2IR was invented in the mid-19th Century, to improve technologies and other new systems introduced in the 1IR. Atkeson, & Kehoe (2001) refer to the 2IR as the transition to a new economy. This generally indicates the impact that the 2IR brought to grow the economy. During this period, pre-existing industries that mostly dealt with minerals such as steel, oil and electricity fields, were expanded into increasing the level of production, to boost the country's income.

As the changing demand took place over time, a constant shift from one industrial revolution persists and this led to the Third Industrial Revolution (3IR). According to Cooper (2009), this

industrial revolution is associated with the second academic revolution (which is associated with ICT, biotechnology, etc.), and this transformation was said to be impossible without knowledge. It is believed that we are currently in this IR and slowly gravitating or moving to the 4IR. Through this deviation, it is quite significant that society itself is being prepared for the upcoming IR to be able to operate and run all socioeconomic processes successfully. It has been suggested that this has to be done efficiently through the education system. This is affirmed by the citation reflected next.

> *"But probably education is especially important to those functions requiring adaptation to change. Here it is necessary to learn to follow and to understand new technological developments." (Richard R. Nelson and Edmund S. Phelps 1966, p. 69)*

It is an evidential truth that change of systems in the industries and the society as a whole requires an introduction to relevant skills which are aligned to the new systems. It is through education that these skills can be efficiently transferred to society, as it is said to transform and reproduce society in so many ways. Westheimer (2020) argues that education, either formal or informal, has a goal of transferring knowledge and skills to society, to transform it. A mere informal lesson of teaching a toddler to say 'thank you every time they receive something, is a way of shaping and transforming an individual. In this context, it is through education, regardless of its nature, that these newly introduced industrial revolution skills can be transferred to society, therefore, transform it.

2.4. Technologies brought about by industrial revolution

Because of its significant influence on people's daily lives, the Industrial Revolution has been referred to as the most profound revolution in human history. It is believed to bring great change in the society that speeds up economic growth. This change is aligned with the introduction of new tools and theories that could support the change itself. The industrial revolution brought about tremendous advancements in communication and transportation technologies, which were crucial steps in making the world a global village. According to Koh, Orzes & Jia (2019), operations and supply chain management could be revolutionized by these technologies. That had an impact on how people lived, how they died, what kind of art they produced, and how they went about their daily lives. This transformation was qualitative because, in contrast to prior historical events, the industrial revolution did not take place exclusively in one region of the globe. Its repercussions were felt all around the world and had an unparalleled impact on practically everyone. When we consider the industrial revolution, we frequently have a tendency to narrow our attention to only how production and the economy changed, making inventions

and developments the main focus of our discussion. No matter how significant these advancements were, they constituted only a small fraction of the change that industrialization brought about.

Technology is regarded as the dominant factor that successfully conduct this transformation. The industrial revolution brought about technologies such as steam engines, harnessing electricity, telephones and telegraphs, and so on. With the employment of machines, which are distinguished by new energy sources, the industrial revolution resulted in an increase in production. For instance, John Kay's flying shuttle invention in the British textile industry in 1733 dramatically accelerated weaving pace, which in turn raised demand for yarn and sparked the development of the Spinning Jenny and the water frame. Prior to the invention of the steam engine, which allowed flying shuttles to be used in enormous cotton mills, similar procedures were soon mechanized using waterpower.

Modes of transport such and team power trains and cotton machines were implemented in the 18th century, with the aim of speeding and increasing production. Considering the increasing population growth and the increase in rates in the economy, as a result of the 2IR, electricity was implemented. Technologies associated with harnessing electricity included natural resources, of which may later be used up. These technologies became part of human lives. This includes telephone, telegraphs, radios, and so on. During this period, communication was able to take place, though it was not accessible to every individual.

A total switch occurred as more advanced technology was implemented in the 3IR, such as digitalization, artificial intelligence, robotics, and so on. Moll (2021) refers to the innovation of these technologies as the 'digital revolution'. This is the new age technology period as it brought complexity in all areas of the society. According to Moll (2021), the following 3IR technologies are as those that mostly brought breakthrough in terms of industrializing the society:

Digitalization: Although this is not a technology, the idea of creating technologies in particular fields is still important. Digitalization is the main driver of change in both society and business (Reis, Amorim, Melão, Cohen & Rodrigues, 2019). For the purpose of improving output, various sectors are introducing new technology. When used in an environment where the educational system is well-equipped, the introduction of digital tools like laptops and whiteboards is seen as an investment because it makes administrative tasks easier to handle and speeds up output. Reis, et al. (2019) claim that investing in digitization will help the economy and society.

Artificial intelligence: The study of artificial intelligence focuses on developing computer

programs that can carry out intelligent tasks that previously required humans alone (Zhang & Lu, 2021). This is the capability of a computer to conveniently process information and practice according to the abilities of a human. This notion simply encourages the use of technology to accomplish human capabilities in a more convenient and accurate way. As the first theorist to introduce the study of artificial intelligence in the late 1950s, John McCarthy defines artificial intelligence as the science of a computer meeting human tasks without biologically observing and being physically involved in the situation. The extent and capacity of human memory cannot be compared to that of a computer, as a human mind may be limited in terms of memory.

The notion of artificial intelligence relates to the process of algorithm as processes and actions of the computer are totally programmed. The capacity of a computer to be able to calculate figures on Excel within seconds lies in the programming and algorithms associated with the computer. Algorithms are essential to automated systems because they serve as specifications for data processing.

Robotics and Machine learning: The development of digitals enabling them to perform human tasks in the most paramount goal of robotics and machine learning. This includes the knowledge one may have regarding the intention of the tool and the significance in accomplishing a certain task. The end result will be a computer that can run algorithms to access and process data, learn from its experiences, and gradually enhance its information-processing skills on its own (Moll, 2021).

Internet of Things: It refers to as computer-to-computer data transfer. Without the involvement of a person, this is accomplished (Moll, 2021). When the temperature rises, an air conditioner may switch on as an illustration of this element, leading to the monitor showing the estimated temperature for the day. These things happen with the goal of being convenient.

2.5. Affordances brought by Technologies in Education.

The primary goal of transitioning from one industrial revolution to the next is to improve the economy and society. Though it may appear distant and almost impractical given that society is still based on traditional and manual ways of life, it is necessary to plan for the gradual transition to the 4IR. Because of the 4IR's characteristics, digitals and ICT appear to be the most effective resources to use in the 4IR. Preparation for this era is very mandatory in order to create an employable and well-equipped society. In a classroom setting, the content taught, and the methods used to teach it should be relevant to the societal context. “Global society is changing because of the shifts in technological capacity. Higher education must change with it.” (Gleason, 2018). This

is to say that change should occur not only outside of the classroom but should also be supported by methods of teaching this change and content based on this change. As a result, the society is fully prepared for the change.

It is of paramount importance to start by discussing the term 'technology' itself. Cloete (2017) sees technology is an embedded social medium aiming at providing services or meeting human needs, such as communication and access to information. In other words, technology is centered on technical routines to accomplish and meet human needs. This is done through the utility of types of machinery, technical devices, scientific knowledge (proven and procedural knowledge), the internet, etc.

Alongside technologies are its affordances, which can be identified as benefits and results that these technologies intend to deliver. In general, Gibson (1977) perceive affordances as those aspects that reflect values and meanings of a phenomenon, in such a way that it becomes an advantage. In agreement, Bobsin, Petrini, & Pozzebon (2019) describe technology affordances as technology potentials that come from a goal-oriented behaviour of technology and turn into concrete actions. This suggests that technology affordance exists through practice. They simplify things, are more convenient and beneficial. The following are some of the technology affordances that Hoven (2007) suggest, can be obtained and experienced through the practice in the education system:

2.5.1. Communication opportunities are increased

Before technology, communication was not always so simple. Education and communication are two of the most notable ways in which technology has aided civilization. It has also altered how people enjoy themselves, engage in politics, and work. Technology and society are inextricably linked. Through technology, an individual can get access to many people, regardless of the distance between them. Unlike the old (manual) way of doing things, with technology, a class discussion can be conducted without having all the participants in one place. Technology also allows an individual to communicate in more than one way. It can be in a form of text, graphics or vocals. "It affords the ability to observe entire work processes in action from end to end, represented through language or images that aid our thought processes in important ways." (Adler-Nissen & Drieschova, 2019). It is therefore beneficial to the education system when technology is integrated. In a classroom context, the use of technology would be an advantage as the teacher would be able to present content in different ways, and learners

respond to it in whichever way they like. They can use digital presentations, use online resources, etc.

2.5.2. Access to multimodal information anywhere, anytime:

Technology is capable of availing any kind of information through the internet and display it in any form. By using technology, one is able to structure and arrange information in their suitable form and further utilize it in any way. Prior to the advent of technology, teachers primarily used textbooks and explained concepts on the blackboard. However, with the advancement of technology, they are acquiring extensive knowledge and providing students with an understanding of the concepts.

Kapur, Panwar & Singh (2019) emphasizes on the fact that technology has brought variety of resources and information will is easily accessible and allows an individual to choose from, according to the own preferences. An individual's preferences are benefited by having access to several multimodal information sources. According to a study by McKay, Wood & Brantley (2019), learners with strong communication skills are able to select the best teaching strategies and convey information in a way that would be clear to them. One person could prefer pictures over text, while another would prefer data to be presented in the form of graphs and tables. This enables students to successfully acquire knowledge using resources of their choice.

2.5.3. Cognitive growth

Being exposed to a wide range of information and perspectives broadens an individual's cognitive development. This is what Piaget (2000) refers to as cognitive constructivism. Individual interactions with various content presented in various ways may encourage the construction of one's own knowledge. An individual may connect the dots and demonstrate links, allowing them to construct their own theory and conclusions.

According to Budd (2008), one cognition grows as a result of experience. In a classroom context, pupils get exposed to a variety of information of which can be presented in different ways. Hence, this promotes cognitive growth. Furthermore, it enables an individual to create his or her content. The ability of technology to present information in multimedia format provides learners with the potential to engage with each other and simultaneously enable them to retain more information from the lesson. Learners can construct their knowledge with the information that they interact with.

2.5.4. Time consuming and convenient

With the exposure that today's generation of learners has to technology, it is easy for them to engage themselves in lessons and go an extra mile into seeking knowledge on their own (independent learning skills). This is convenient, especially because most pupils use technology daily.

These are just a few of the many key affordances technology offers that may turn out to be beneficial and an advantage to the education system. Perhaps, South African education needs to adopt the education that is aligned with change that the IR brings to the fore. This prepares learners to be relevant for their future endeavors, which is already dominated by technological skills. It makes it clear that society evolves, and it is through the IR that developed and advanced systems are being invented.

2.6. Skills needed by 4IR

Schwab (2017) dwells on the concept of 4IR in his book *The Fourth Industrial Revolution*. He does this by describing the 4IR as an upcoming period which intends to bring global transformation that will affect way of living. He further describes it using a phrase 'this time is different', to emphasize on the changes that will be seen and experienced as different from the 'normal' way of living. However, this does not only necessarily affect human lives, it also touches a lot on industries of which mostly contribute to the standard of living.

> *"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change"* - Darwin & Wallace (1958)

As mentioned above in the study, education is the most convenient system of transferring these skills to the society. According to Blinder (2006) the formal education system is there to prepare pupils to perform the tasks needed and remunerated by the job market. Only those who have be equipped with the 4IR skills and are able to operate in the 4IR industries are capable of maintaining the standard of living. Therefore, it is in the education system that these skills are integrated, with the aim of being applied in the 4IR. According Nhede (2018) the following are some of the skills required for the 4IR:

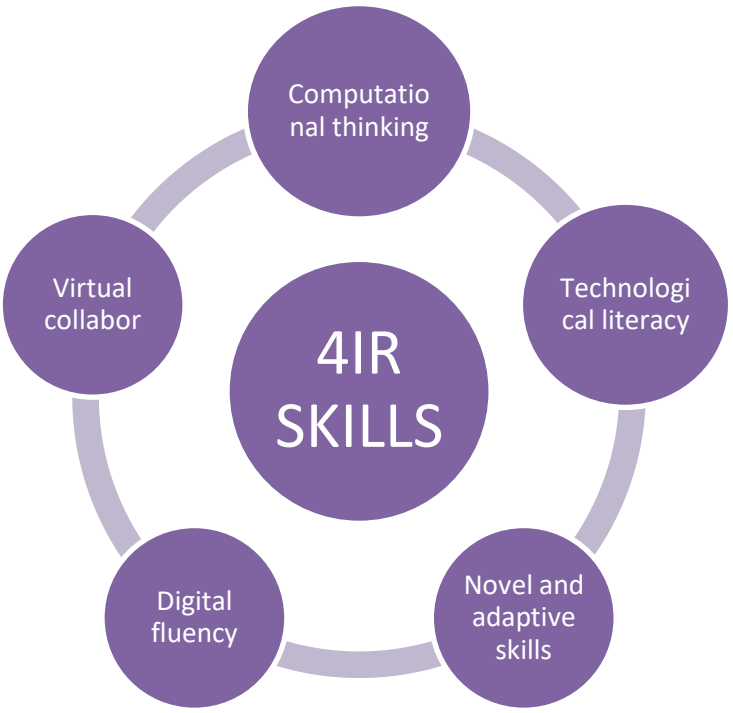


Figure 2: 4IR skills

4IR skills are computer digital based. They promote the system of operating everything with the use of digital computers, or rather ICT. For example, robotics, humanoids, artificial intelligence, genomics, etc. As much as the society is already exposed to digital computing, 4IR brings an extension to these skills.

2.6.1. Computational thinking: This is a cognitive skill. Computational thinking is defined as the capacity for cognition and reason, as well as the capability to perceive, comprehend and benefit from experience (especially to a high degree). Creativity, skill, awareness, emotion, and intuition are other terms used to characterize characteristics of intelligence (Engelbrecht, 2007).This means that providing immediate answers to problems is essential and crucial as one of the 4IR abilities required. This includes reasoning, critical thinking and analyses towards instances. Technology teachers can promote this skill using scenarios that will require learners to bring solutions with clear reasoning analyse. We may use computational thinking to take a complex situation, identify the issue, and create potential solutions. Then, we may communicate these profound solutions in a way that a machine, a person, or both, can comprehend.

Subsequently, this can be aligned with Bloom's Taxonomy (Bloom, 1956) as teachers can develop the cognition of the learners by challenging them. “It focuses on developing thinking ability which involves simple information acquisition to more complex processes”, (Bloom,

1956). Bloom's taxonomy collates high order thinking which is equivalent to computational thinking as it is accomplished through an algorithmic process.

2.6.2. Technological literacy and digital fluency: The ability to apply technological devices and being fluent and creative with them at any point is very much necessary. As Tsekeris (2019) argues that indeed this 4IR is expected to be technology-centered, therefore requires one to be able to navigate through such an environment. In a classroom context, this skill can be promoted by encouraging the use of digital devices through lessons. For instance, online tests and assignments.

2.6.3. Novel and adaptive skills: This is totally aligned with the cognitive computational thinking skill, as it is all about the ability to think through problems. An individual may be able to come up with solutions beyond the standard procedure of tackling and solving cases. In this case, the 4IR era requires one to think and bring solutions instantly. According to Kim, Kim, Song, Cho, Lee, Park & Yoo (2021), novel thinking must be flexible. To put it another way, creative thinking must be tailored to the situation at hand in order to be effective. The most potent ability of the future is thought to be adaptive new thinking.

2.6.4.Virtual collaboration: According to Schwab (2017), the global transformation from the more physical to a more virtual approaches of navigating life. As the required skill of 4IR, the ability to virtually solve problems is of paramount, as it is associated with digital living. Activities such virtual meetings and live chats can be applied by the teacher with the aim of developing this skill.

What matters in a society is the change that these skills bring about. The transition itself is essential; without it, the society would not advance. It is also important to highlight that changing teaching strategies are necessary in order to impart new skills.

2.7. 4IR and Education

Nearly all facets of society have been affected by the upcoming 4IR. This is because in order to function in the 4IR's new workplace, new skills must be learned. The South African government aspires to develop a technology- and science-based economy. To generate jobs and address industry issues, the economy will be industrialized (Oliver, 2022). Industrial parks and innovation hubs will be built, allowing consumers to actively participate in the production process. This will help to raise the level of living for people in South Africa and create jobs. In the innovation centers, "researchers and business specialists" such as teachers, will actively share their knowledge, fostering a favorable environment for the advancement of technology. To reiterate, 4IR introduces

several technologies that are expected to change the landscape of industries such as education: Internet of Things, Big Data, , Wireless Sensor Systems, Cloud Computing, , Robots, Coding, and Augmented Reality (Diño & Ong, 2019).

The South African curriculum evolves throughout time to include the skills and information needed to boost the country's economy. Currently, CAPS documents are used in South African public schools. These documents aim to develop a united and democratic South Africa by preparing the next generation for a society founded on democratic ideals and social justice. In contrast to the South African Curriculum formerly in use, the CAPS curriculum provided fresh approaches to teaching and learning. According to Schwab (2017), the so-called 4IR is now in place and will soon be implemented in other nations, so the educational system must adhere to its requirements. These expectations cover the knowledge and abilities required for the economic growth brought on by digitalization and artificial intelligence. The implementation of CAPS on Robotics and Coding in South African schools from Grade R-12 has played a huge role in familiarizing learners with necessary technology skills. According to (Curriculum and Assessment Policy (CAPS), 2021), the CAPS Robotics and Coding serves to:

- Helping and equipping students to solve issues, think critically, collaborate and be creative, live in a technological and knowledge world, and use technological and ICT skills to solve problems and explore possibilities.
- Enabling students to successfully engage in a world that is changing and evolving quickly.

These aims are totally aligned with the expectations of the 4IR, and it is a little bit in contrast with the intentions of the Technology subject CAPS. According to De Jager (2011), the Technology CAPS Document was introduced in order to produce the engineers, technicians, and craftsmen required in contemporary society as well as the necessity to create a society that is technologically literate. The nation and its economy as a whole benefited greatly from this at the time, but not today. If the policy is no longer fulfilling the intended goal, it must be changed immediately. This educational policy (paradigm) shift aims to improve and standardize South Africa's educational system and generate high-caliber talents (Bird, 2000).

Bagheri & Mohamadi Zenouzagh (2021) claim that face-to-face instruction is likely to be replaced by new learning resources including online, peer-to-peer, MOOCs, informal learning like viewing videos, reading, and attending seminars, as well as in-the-moment learning like AR-assisted

performance. Online education acts as a bridge, giving students a quick opportunity to get a better comprehension of the material and to interact with it. Due to their extensive exposure to the digital environment, learners currently prefer the digital method of learning. Bagheri & Mohamadi Zenouzagh (2021) go on to highlight how early childhood and primary education should focus on teaching students how to learn rather than what to study, which is undoubtedly a crucial move for preparing the next generation for the workforce. The workforce of the alleged fourth industrial revolution.

An awareness of how to use digital technologies efficiently while working in collaboration and across many disciplines is essential in today's job environment. A new learning framework that incorporates these 21st Century Skills into the curriculum and imparts content knowledge while building the hands - on practical and cognitive abilities is needed to teach these skills in schools. Currently, the South African curriculum includes instruction in cognitive abilities like critical thinking, problem solving, and creativity. Digital tools, according to Joynes, Rossignoli & Fenyiwa Amonoo-Kuofi (2019) on the other hand, can expand and improve this while also exposing students to digital technology. Important among these are:

- Personalized learning: Learners advance at their own speed with individualized instruction. Because learners are mandated to keep pace with (or slow down to) most of the class, offline/non-digitized learning presents a challenge. With the help of digital education, teachers may customize learning pace to suit each student's needs. By allowing some students to practice more and others to move on when they are ready, it enables the development of cognitive abilities at the level of the each learner's capacity.
- Expanded learning: Expanded learning is the term for additional learning possibilities that are not often offered in a traditional classroom setting. With access to extra resources, digital education can give students of all abilities the chance to either deepen or broaden their knowledge and skills, or to consolidate and/or enhance them by working on related assignments and supporting activities.
- Increased engagement: The cornerstone to engagement and subsequently learning is learner motivation. Teachers have potential to improve student performance by increasing learner engagement with the particular topic through digital education approaches like game-based learning. Additionally, having access to relevant and varied stuff online enables students to not only broaden their understanding but also grow in their capacity for information literacy.

- Collaborative learning: Collaborative learning is simple to deploy in a digital learning environment. Three important aspects are made possible by digital platforms: professors can assign group assignments; students can work together to accomplish assignments; and teachers can track students' individual efforts and progress toward completion. Additionally, cooperative learning situations offer students priceless chances to speak with one another and critically assess one another's contributions in order to work as a team to solve difficulties.
- Assessment for learning: The ability of the teacher to evaluate students both morphologically and formatively in order to precisely pinpoint the cognitive abilities that are deficient is improved by digital education. As a result, teachers can provide effective and appropriate personalized learning opportunities thanks to digital evaluation programs. Furthermore, students who participate in game-based learning programs perceive each task as a new challenge in a competitive atmosphere, rendering the assessment process opaque to them.

The main mechanism for imparting 4IR information and skills to society is the educational system. Therefore, in order to effectively impart these talents, the educational system must be shaped and modified. The main focus of instruction in South African schools is the CAPS document. The knowledge of the 4IR skills and strategies for teaching them should be included in this policy.

2.8. Pedagogy practice by Technology teachers.

Pedagogy is one of the most paramount factors to be taken into consideration when conducting a lesson. The term "pedagogy" has become more common in educational jargon as a replacement for "methods of instruction" or "teaching strategies" (Loughran, 2007). This instrumental perspective of pedagogy rationalizes and simplifies the labor of teaching to a broadly applicable skill set, which is based in part on the misconception that educating is a technological activity. As a result, the intimate decisions and interactions that eventually make up education are frequently left out of the scientific study of pedagogy. However, because teaching is a contextual, reflexive activity that calls for teachers' judgment in interpreting practice-related events (Grimmett & MacKinnon, 1992), the reasons behind curricular and instructional decision-making are just as much a part of pedagogy as the actual decisions themselves. The lesson is expected to be structured in an accommodative way with regards to the content to be presented.

Technology is playing a more and bigger role in kids' lives outside of the classroom, and it can even assist pupils learn more difficult concepts or foster peer collaboration. Because of these advantages, modern educational theory advises that teachers include some sort of technology into their classrooms, yet many educators find it challenging to do so. Implementing technology in the classroom is frequently hampered by issues with cost, accessibility, and time, but another challenge is a lack of understanding on how technology may be used most effectively to help students in a variety of subject areas. The 2006 TPACK framework developed by Punya Mishra and Matthew J. Koehler, which emphasizes technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), provides a useful solution to many of the challenges that teachers encounter when integrating educational technology (edtech) into their classrooms. The TPACK framework describes how content (what is being delivered) and pedagogy (how the instructor transmits that content) must be the foundation for any successful education technology integration by discriminating between these three forms of knowledge. This arrangement is crucial because, in order to improve students' learning experiences, technology must both communicate the information and complement the pedagogy.

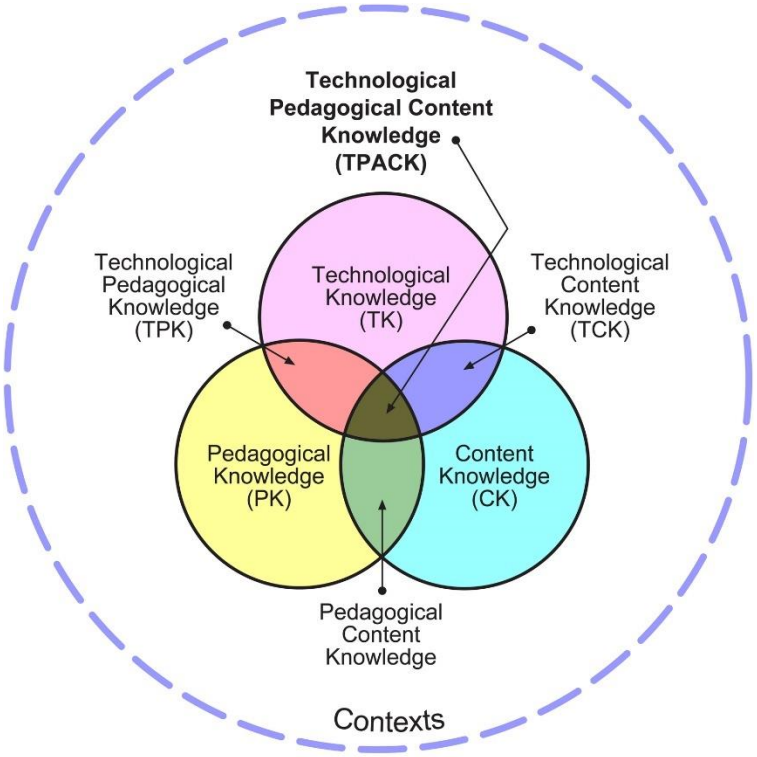


Figure 3: Punya Mishra and Matthew J. Koehler's 2006 TPACK framework

The TPACK framework's eight main knowledge building blocks are as follows:

- Content knowledge (CK): Any understanding of the subject matter that a teacher is

tasked with imparting is referred to as content knowledge (CK). According to Shulman (1986), content knowledge includes familiarity with the topic and its logical organization. Shulman (1986) emphasized further that understanding a subject well enough to teach it calls for more than just knowing its facts and concepts. Teachers must also be aware of the structuring principles, rules, and regulations that define what is appropriate to say and do in many fields. The teacher must comprehend not only that something is true, but also why it is true, what grounds might be used to support it, and how our conviction in its validity may be undermined or rejected.

- Pedagogical knowledge (PK): Understanding of teaching, techniques of "expressing and articulating the concept that makes it intelligible to others," and "how particular themes, problems, or difficulties are arranged, presented, and fitted to the different interests and skills of learners" (Shulman, 1987, pp. 8-9). Knowledge of the procedures, techniques, or approaches used in teaching and learning is referred to as pedagogical knowledge. This body of knowledge covers all topics related to student learning, classroom administration, the creation and delivery of lessons, and student assessment. This kind of knowledge includes the use of aiding resources, such as digital technological resources, with the aim of enhancing the delivery of the lesson. However, it lies in the nature of the concept to be taught, that certain resources are used. It is through the teacher's pedagogical knowledge that the content is structured and delivered successfully.
- Technological knowledge (TK): This section describes teachers' knowledge and ability to use different technologies, digital gadgets, and related resources, ranging from low-tech tools like pencil and paper to high-tech tools like the Web, video streaming, smartboards, and computer programs.
- Pedagogical content knowledge (PCK): It speaks about the subject-matter expertise related to the instructional process (Shulman, 1986). Since it combines both pedagogy and material with the aim of improving teaching methods in the subject areas, pedagogical content knowledge differs for distinct subject areas. This kind of knowledge emphasizes the importance of a healthy relationship between content knowledge and the structural and methodologic part of it. When content knowledge is structured effectively and delivered correct, then the lesson becomes a success. It implies that content knowledge and pedagogy are inextricably linked.
- Technological content knowledge (TCK): This kind of knowledge deals with the

integration of technological digital resources with content knowledge. According to Schmidt, Baran, Thompson, Mishra, Koehler & Shin (2009), knowledge of the new representations that technology can produce for a certain piece of material is referred to as technological content knowledge. It implies that educators are aware of how a certain technology might alter how students practice and comprehend ideas in a particular subject area.

- Technological pedagogical knowledge (TPK): This kind of knowledge refers to instructors' awareness of how advanced techniques can be utilized in the classroom and how employing technology may alter how a person teaches. Koehler et al. (2014) perceives TPK as understanding how technology might restrict and afford particular teaching approaches. Therefore, a teacher requires technological skills in order to fully and effectively integrate technologies with content knowledge.
- Technological pedagogical content knowledge (TPACK): This is an umbrella of the relationship between technology, content and pedagogical knowledge. It emphasizes the importance of the teacher to make use of these three components in order to successfully deliver a lesson. According to Koehler, et al. (2014), knowledge of the intricate relationships between technology, pedagogy, and content is referred to as TPACK, and it is this knowledge that enables teachers to create effective and context-specific teaching tactics. Because this type of knowledge is so complicated, it might be difficult for a person to learn it all at once. For this reason, it has been divided into a number of straightforward categories.

According to Wilson-Strydom, Thomson & Hodgkinson-Williams (2005), in the South African context, the quality of the education system is seen to be less developed, compared to other countries, and this affects its outputs. This suggests that as a foundation of economic growth and successful 4IR, the education system is most likely to slow down the process of development, as it is not well developed itself. Pedagogies that teachers apply in their classroom are no longer effective, as they are not aligned with the requirements of developing the country, such as the integration of ICT and so on.

Naicker (2010) strongly believes that the use of computers as part of teachers' pedagogy will have a huge impact in enhancing the lessons in the classroom. This is because, as we are in the 21st century and digital gadgets are mostly used in our society in different situations, such as social media, news, articles, and any kind of resources, and integrating such gadgets in

education would be an advantage. Khoza & Mpungose (2018) conducted a research in a Higher Education Institutions whereby most first year students indicated that they very much appreciate the use of social media platforms in their learning as they are accustomed to them, which is a reflection of most grade 9 learners. However, due to the lack of resources in most public schools in South Africa, this deprives teachers of an opportunity to engage in technology, or rather ICT integrated pedagogies, argues (Sedibe, 2011).

It is an undeniable truth that due to the reproduction of living standards, there will never be quality in the distribution of resources within the society. This is understandable because of the difference in social classes. The working class is most likely to afford less-resourced education than the elite. Therefore, education served in a working-class neighborhood (in townships) is most likely to be less developed compared to schools for the elite. According to (Sedibe, 2011), less access to resources in disadvantaged South African schools affect their education system, the inputs that schools put (with include pedagogies) and outputs (which can be in a form of outcomes of lessons and assessments).

2.9. Conceptual Framework of the research

A conceptual framework is referred to as a network of related models, (Shabiralyani, Hasan, Hamad & Iqbal, 2015). A method of theorization for developing conceptual frameworks based on the grounded theory approach is provided by conceptual framework analysis. In order to determine the extent to which Technology grade 9 learners are being fully prepared for the 4IR, the study will engage the conceptual framework for the development of 4IR skills that Kamaruzaman et al. (2019) developed. This framework is a foundation of the research itself.

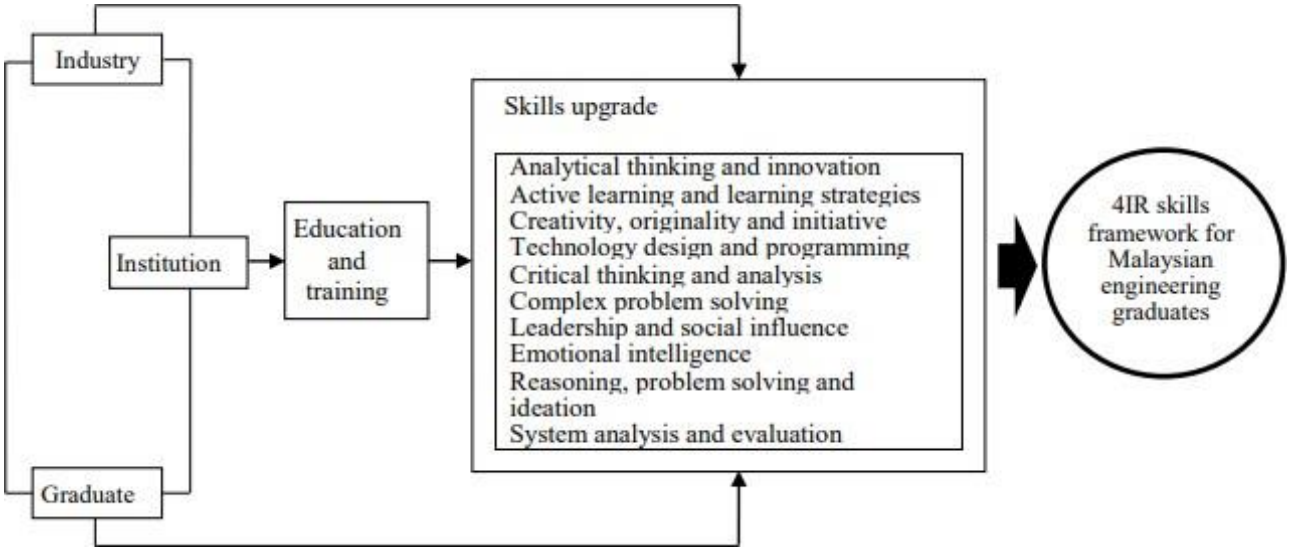


Figure 4: Conceptual framework for development of 4IR skills (adapted from Kamaruzaman et al (2019))

According to Kamaruzaman et al (2019), this framework is a combination of two models: the industrial and institutional relations model and the Frye model.

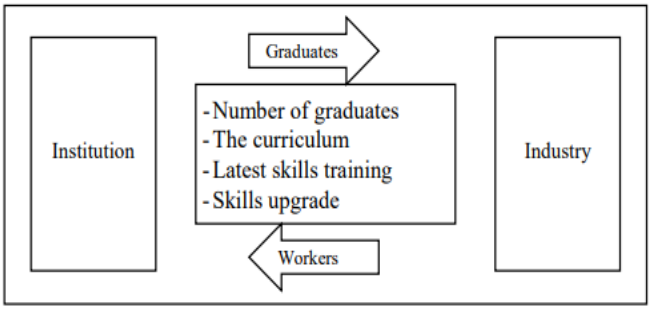


figure 5: industrial and institutional relations model (adapted from Kamaruzaman et al (2019))

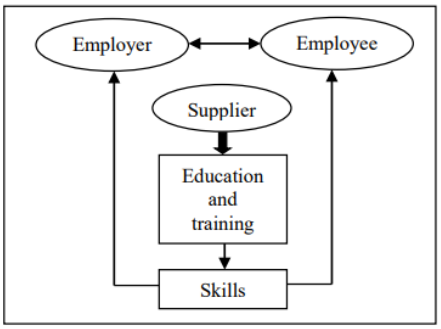


figure 6: Frye model. (adapted from Kamaruzaman et al (2019))

The focus of industrial and institutional relations model is on the knowledge provided by institutions and if the graduate's knowledge is in line with the demands of the industries. The three parts are also emphasized by the Frye model, according to which the institution is responsible for implementing particular knowledge and abilities that are required by the employer (industries). These abilities are also required of the employee (the graduate), who depends on them to break into the industries. Kamaruzaman et al. (2019) combine these two models into one framework due to the fact that they both focus on main components that play a huge role in shaping and improving the economy. This framework is very much significant

to the study as it outlines 4IR skills that can be obtained through education and shows the relationship of these skills to the industries.

The conceptual framework for the development of 4IR skills by Kamaruzaman et al (2019) shows connection the three main components: institution, graduate and the industries. This stipulates the effect that education has on the operations of the society, as it is the foundation of the consciousness of individual in the society.

> *"Industry depends upon our schools to provide well educated and trained personnel in sufficient number and in turn the schools depend greatly on industry to provide employment for our youth and for guidance and financial support in their studies"* – Cuthbert & Konig (1965)

Even while businesses rely on educational institutions to provide graduates with the essential skills and information, it is important to note the influence that businesses have on education as well. The degree of inequality in our society has been explored at the beginning of this study. In contrast to most middle-class areas of society, where it is fairly uncommon to find a family that can afford good quality education, the elite segments of society are more likely to get great education since they support their education. Therefore, just as much as institutions depend on industry, industries likewise depend on institutions so that people can save money and pay for a quality education.

Generally, industries introduce certain breakthroughs that might drive them to rapid output through technological improvement. Educational institutions exist to prepare students to fulfill the anticipated industry requirements. However, while the framework suggests certain connections between the two, this is not the case in practice. A change in the education system necessitates a shift in resources and pedagogies, followed by the establishment of suitable infrastructure, such as 21st century classrooms equipped with digital resources. As a result, there is a need to include technology into education in order to prepare learners for 4IR skills and knowledge.

Digital education can offer learners across the ability spectrum additional opportunities to either extend their knowledge and skills by having access to extension materials or to consolidate and/or improve their knowledge and skills through doing support activities and by practicing similar tasks." (McNulty & Carter, 2018). Due to the nature of some public South African schools, Technology teachers are most likely to fail to apply such digital and ICT centered pedagogies. This is simply because of a lack of resources, such as computers and smartboards

coupled with the appropriate training towards the use of digital tools in teaching. Therefore, pedagogies that Technology teachers apply are only effective when they are integrated with technological resources in school with sufficient resources, to promote the development of 4IR skills.

Chapter 3: Research Design and Methodological approach

3.1. Introduction

Research is a structured study that aims to obtain knowledge on a certain research problem. Johnson & Onwuegbuzie (2004) breaks the term research into ‘re’ and ‘search’ to show the main importance of conducting a researching with the aim of obtain updated knowledge in relationship to relevant events that could benefit the society. The study is aimed at determining the extent to which Grade 9 Technology learners are being prepared for the 4IR. Due to the qualitative nature of the study, the following research question centers the study:

How do Grade 9 technology teachers prepare learners for the 4IR in their teaching practice?

The research question will be answered addressing the following sub-questions:

- What methods of teaching do technology teachers practice, that prepare learners for the 4IR?
- What are the 4IR skills that technology teachers should impart to learners?
- What digital technological gap (knowledge and skills) do technology teachers have when using digital tools that may prepare learners to meet the needs of the 4IR?
- How do technology teachers envision ideal ways of preparing learners for the 4IR terrain?

This chapter will delve into the methods and designs used to structure the research and gather knowledge in order to provide answers to the research question.

3.2. Research design

We can define a research design as the arrangement of parameters for data collecting and analysis with the intention of generalizing the sample's results to the population, (Johnson & Onwuegbuzie, 2004). According to a fundamental concept of the phenomenon of research, a framework must be followed in order to achieve the goals of a study. The structure that outlined the method used to perform the study is known as the research design. The outline of the research design that is detailed in the figure below. The research methodology that was used is stipulated, the participants, and how they were sampled. The methods utilized to carry out this study are also presented, along with a description of the equipment used for data collection. The framework also discusses methods that were employed to analyze the data.

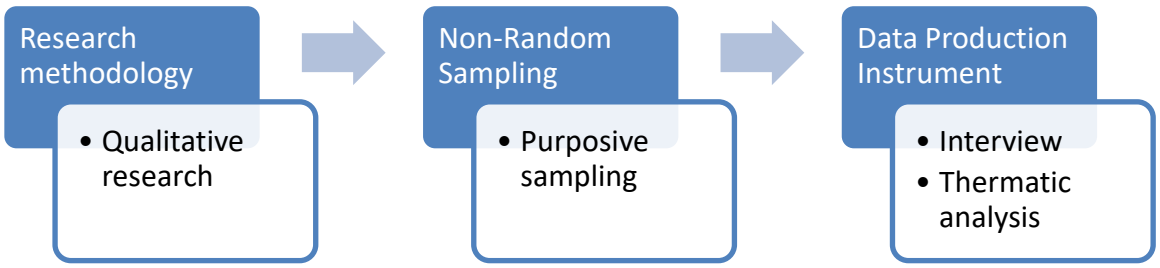


Figure 7: Research methodology and design outline

3.3. Research methodology

Research methodology is known as the steps or methods used to find, choose, process, and evaluate material on a subject. The methodology part of a research paper gives the reader the chance to assess the general validity and dependability of a study. Denzin and Lincoln (2005) view research methodology as determined by the type of the research question(s) understudy and the phenomenon being investigated. The research question provides a platform in which research methodology the researcher will follow. With regard to the gathering and acquisition of pertinent data, accompanied by analysis and interpretation, which will result in a final product in the form of usable knowledge, the current research is a systematic, logical, and sequential development.

The study used a qualitative research methodology as it reinforces an understanding and interpretation of meaning that obtained through human interaction. Data was collected using in-depth interviews. Denzin & Lincoln (2011) mention the following about principles that involve qualitative research:

- Qualitative research is holistic; it looks at the larger picture and begins with a search for understanding of the whole.
- Qualitative research looks at the relationships within a system.
- Qualitative research focuses on understanding a given social setting, not necessarily on making predictions about that setting.
- Qualitative research demands time consuming analysis; it requires ongoing analysis of the data.
- Qualitative research design requires the researcher to become the research instrument. It also incorporates room for description of the researcher's own biases and ideological preferences.

In this study endeavor, qualitative research is favored. Describes qualitative research as the one in which the researcher is the main instrument of data collection and analysis. The research

interacts with the participants directly, in consideration of the context of the research. The information was collected through interviews, of which the researcher persuaded the participants to describe the nature of the phenomenon explicitly in order to provide a description of the experiences of the participants. The word-by-word transcription of the interview recordings ensures accuracy of the data collected. In that case, findings can be analyzed and answers to the research question can be provided with quality.

3.4. Research Process (Philosophical assumptions)

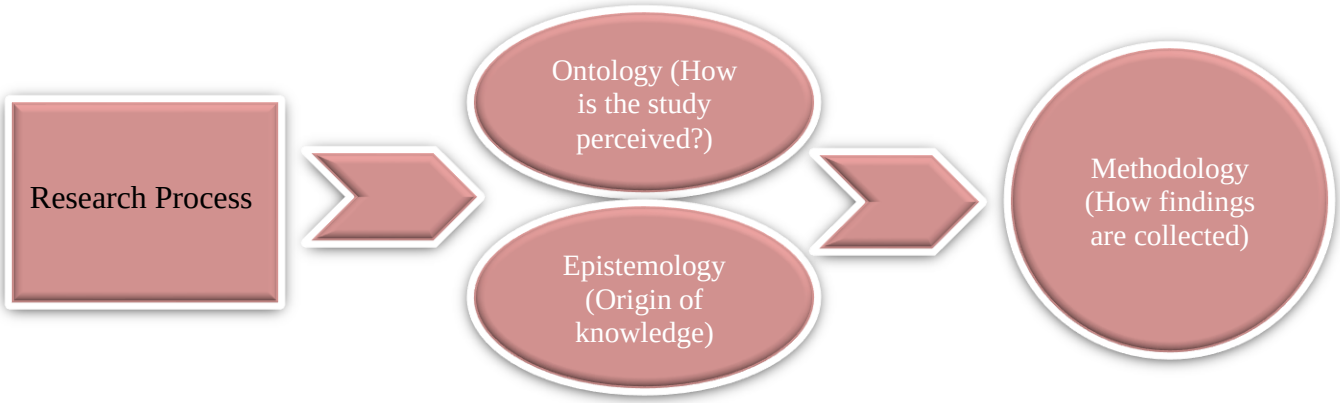


Figure 8: Research process

To produce a genuine and accurate study, good research is influenced by philosophical ideas and beliefs. Finding out where qualitative research fits into the larger research process, realizing its importance as a component of research, and considering how to actively include it into a study are the first steps in understanding the conceptual underpinnings of qualitative research. Philosophy is the use of philosophical ideas and principles to direct our studies. Philosophical presumptions are usually used as the first thoughts when creating a study. These presumptions affect how research questions are developed and subsequently conducted (Graue, 2015).

Therefore, in this study, philosophical assumptions were based on the study of how experience is believed to be (ontology) and the study of how knowledge is perceived (epistemology). This intend to support the extent to which the research is valid and can be relied to. The philosophical underpinning of a research project is the researcher's ontological and epistemological positions, which have an impact on every step of the research conduction and procedure.

3.4.1. Ontology

Crotty (2003) describes ontology as "the study of being." (Ahmed, 2008). This study focuses on the nature of existence, how are things perceived to be. It describes what existence is, what it is, and how things are categorized. Some people could think that everything is basically one and that everything in reality is interconnected and identical. Others believe that there are countless different types of real items in reality. Philosophers have long studied ontology, often known as the study of being, and it is used in many other fields. It can be viewed as fundamental since how one understands reality, how to interpret it correctly, and how to effectively categorize what is genuine will have a big impact on how they work within their profession and how they comprehend and do research. The assumptions of the researcher may have an influence in the focus of the research and how the research is carried out. These assumptions may be influenced by the nature of how the society is perceived to be. The fundamental question of ontology is whether social entities should be viewed as objective or subjective. Decide whether the universe is external to the social world or whether social actors' perceptions and behaviors produce social phenomena within the parameters of your inquiry.

Given the difference in the environment and setting in different schools, it is paramount to take into consideration difference experiences that may partake in the process of education. This qualitative study focuses on public schools of different settings; therefore, it remains important to assume that experiences and the view on certain things may differ and may be idealistic. Idealism is an ontological perspective that claims that one's mental makeup and activities determine what is real (Guba & Lincoln, 1994). Idealism holds that ideas, consciousness and reality are founded on experience and are therefore arbitrary. Because experiences can never be universal, it can never be universal. Ideas serve as the foundation of idealism and are regarded as the only things worth knowing. As a result, it emphasizes the mind, which serves as the source of all thoughts.

Bryman and Bell (2011) state that researchers' assumptions may be based on two considerations, including whether social entities should be subjective (constructionism) and based on society experiences and structure or should be objective (objectivism) and based on findings and theories

(Mayer, 2015). According to the constructionist theory, knowledge is created by people, in part through social interactions, rather than being seen as an insight into some objective truth. According to objectivism, social entities actually exist outside of the social players who are concerned about them. It contends that social entities have an existence separate from social actors. In contrast, subjectivism (sometimes referred to as constructionism or interpretivism) holds that social phenomena are shaped by the perceptions and subsequent behavior of the social actors who are interested in their existence. Formally, constructionism is an ontological position that holds that social actors continuously produce social things and their meanings. How credible is the claim that knowledge is a product of repeated observation of social events? Hegel argues that, because people from various political, economic, and cultural backgrounds perceive and understand societal events in varying ways, we cannot limit knowledge to a reality governed by causal rules (Scott, 2013).

In opposition to positivism, "beliefs" are crucial to the advancement of knowledge. Knowledge can be evidently based on how people see or are conscious of reality; it cannot be based on objective reality. Scott (2013) asserts that knowledge exists in a variety of forms and that in order to comprehend its diversity, we must develop an empathic understanding. This suggests that since everyone has their own subjective perceptions, it is necessary to combine subjectivities in order to produce information that will be understood and have value to everyone. Even while our minds actively build impressions based on experience, observation depends on interaction (Feinberg & Soltis, 2009). After highlighting the interpretivism through which knowledge develops, it is critical that we make a radical shift from viewing knowledge as an objective truth to understanding the meaning of our world, leaving no room for positivism to serve as a foundation for world interpretation (Potrac, Jones & Nelson, 2014).

This study follows the subjective perspective as it considers differences that may standout in schools and the knowledge of 4IR that teachers may have. The researcher did not influence the subject of the study and the findings of the study; however, the outcome is based on original setting and environment of the participants. We must move away from Skinner (1968) objective driven forms of viewing education as a discipline that follows the exhibition of "objective" behavior that learners are expected to show to prove their comprehension of the information imparted to them through a revolution that seeks to apply an interpretivism philosophy in education. This is because learning environments can have an impact on both teachers' and

learners' experiences. One cannot generalize about teaching and learning methods. Resources, practices, culture, and instructional strategies found in School A may not always be present in School B. Therefore, it would be obvious that knowledge should not be reduced to an object. The concept of interpretivism can be characterized as one that encourages knowledge to be driven by the interpretation and comprehension of the meanings of observations. As a result, human behavior and social issues can be explained by making interpretations of what we see. In doing so, we need also be sympathetic in order to develop meaningful understanding. implying that in order to comprehend other people's perspectives, we should work to empathize with them.

3.4.2. Epistemology

The way in which knowledge is perceived is totally based on the epistemology attached to it. This is to say, how the society interpret knowledge depends on the theory that they follow. Mi & Ryan (2018) describe epistemology as the theory of knowledge concerned with the justification of beliefs and values of how we may come to know the world. This is the study of the origin of knowledge. The focal point of epistemology lies in the beliefs and values, which are very much influenced by day-to-day experience.

Interpretivism

Epistemologically, although positivism is an ancient paradigm mostly utilised by researchers, due to its objective approach, it is totally not suitable for this study. “Positivism relate to the importance of what is given in general, with more strict focus to consider pure data as well as facts without being influenced by interpretation of bias human.” (Alharahsheh & Pius, 2020). The positivism paradigm is science centered. It simply says, personal knowledge is supported by scientific verifications, trends and principles. Differentiation in terms of context and experience is not believed to play a huge role in the consciousness of an individual. It is entirely objected to scientific theories and principles and seeks to relate these theories and principles to individuals’ consciousness, individuals that come across different experiences every single day.

Unlike the objective route of positivism, the interpretivism paradigm considers the personal aspect of an individual. It was developed with the aim of rectifying unsatisfying objective beliefs of the positivism approach. “Interpretivism is more concerned with in depth variables and factors related a context, it considers humans as different from physical phenomena as they create further depth in meanings with the assumption that human beings cannot be explored in a similar way

to physical phenomena." (Alharahsheh & Pius, 2020). This epistemological paradigm considers differentiation in terms of beliefs, culture, values, environment, and so on. It does not rely on scientific theories that may even be outdates, it does not believe that society is capable of shaping an individual, however, it is through the experiences of an individual that the society is being shaped.

With that being said, this research was conducted according to the interpretivism paradigm. The intension of using this paradigm is to acquire a subjective, emphatic and an in- depth understanding of the methods teachers use when teaching Technology and their reasoning. This is to also gain understanding of possible challenges that teachers and learners may come across, taking into consideration the difference access to components such as resources. Ryan (2018) argues that interpretivism considers truth and knowledge as being subjective, as well as culturally and historically situated. This includes people's experiences and their understanding of them.

Though the interpretivist approach is favored in this study, it is entirely based on interpretation of knowledge, rather than construction. Adom Yeboah & Ankrah (2016) characterize constructivism as a philosophical worldview that holds that humans build their own knowledge and understanding of the world by engaging with it and reflecting on it. This is a paradigm that relates a lot to interpretivism, and they both believe knowledge should be subjective. It must be based on reality and what individuals are exposed to.

Constructivism

This study is also supported by the constructivist approach, whereby participants are believed to construct or to have constructed knowledge based on experiences. According to Wilde & Urhahne (2008), cognitive or ontological constructivism are both possible. Conceptions and assumptions are created by humans rather than being innate concepts or the result of discovery, awareness, or instinct. According to ontological constructivism, knowledge creates reality. Since reality is recognized by constructivism as a creation of the mind, it is believed to be a subjective concept. In addition, pragmatism and relativism are also intimately related to this philosophical outlook. Constructivism's basic tenet is that all knowledge is built on the foundation of human experience. Based on the idea that knowledge and the knower are inseparable, this perspective.

The primary difference between constructivism ideology and positivist is that although positivism holds that knowledge is created via the application of a single scientific approach, constructivism claims that knowledge is created by scientists and rejects this idea. Wilde & Urhahne (2008) claims that constructivism may be constituted by the following:

- relates the researcher to the context
- gathers meanings generated by participants
- concentrates on a specific idea or occurrence
- brings principles from one's own life to the study
- studies the participants' environment or circumstances
- confirms the reliability of results
- explains the data
- develops a plan of action for reform or change
- involves the researcher working with the participants

In this study, consciousness of an individual is constructed through the context they find themselves in, the beliefs and values they live according to and through their everyday basic experience. The knowledge that each participant may have, and how they perceive it, is totally based on their experiences and their context. Each one is taken into consideration and their responses are interpreted without generalization.

Situated Learning

Furthermore, this study was conducted according to the situated learning theory that also emphasizes on context of practice as the most dominant factor that shape an individual's consciousness. Lave & Wenger (1991) developed this theory on constructivism as they believe in the constructing knowledge and consciousness through subjected approaches. Situated learning is specified to a learning setting. In less resourced institution you find a situation where learning does not effectively take place due to lack of resources. It is attached to the surrounding of the classroom setting. So as in this study, findings and knowledge constructed is supported by the context in which learning takes place. Situated learning engages students in cooperative tasks that test their physical and critical thinking skills. These exercises must be adaptable and transportable to students' residences, communities, and places of employment (Stein, 1998). It says, the extent to which learning can successfully take place lies in the context and beliefs in

which it happens.

Connectivism

It is paramount to consider the nature of social knowledge, as it changes over time. According to Shrivastava (2018), connectivism is a theory that believes that learning can occur from the outside, in contrast to earlier conceptions. This theory's foundation rests on the knowledge that any decision made at one moment in time may change as a result of quickly shifting foundations. Continuous information creation and acquisition occurs. Technology has changed how we live, communicate, and learn during the last twenty years. Learning requirements and theories that outline learning concepts and procedures ought to take into account the underlying social contexts. It remains a foundation that knowledge understood today is understood with the consideration of its past, of how it came about.

Acquisition is a procedure that takes place in hazy surroundings with changing basic components and is not totally within the individual's control. The connectivism paradigm contributes to the findings and the conclusion of this study as this study considers the nature of knowledge itself, the fact that knowledge changes overtime, and this may contribute to the way it is understood or perceived. The ideas investigated by disorder, connection, diversity, and identity theories are combined in connectivism.

The study is guided by interpretivism out of all the paradigms stated above since it is primarily concerned with understanding the participants' personal experiences on why they are not applying 4IR abilities in their teaching practice. Furthermore, this paradigm is unaffected by philosophical viewpoints and instead reflects what people are doing on the ground.

3.4.3. Methodology Approach

This research follows seeks to investigate the extent to which grade 9 Technology learners are being prepared for the 4IR terrain. Methodologies might be quantitative, qualitative, or hybrid approaches, which combine the two. The goal of quantitative research is to quantify the data collection and processing process. It is based on a deductive method that emphasizes the validation of hypothesis and is influenced by positivist and objectivist theories (Leedy & Ormrod, 2010). In contrast to quantitative research, his case study will be overcome by following the qualitative approach. Without using any statistical analysis, a qualitative approach entails taking an empirical approach to collect category data, typically from humans, and then looking

at it to see if any patterns can be found. Examining user behavior when they engage with a computer software or analyzing the content of social media posts are two examples of how to do this. Qualitative research is a contextual action that places the observation in relation to the environment (Creswell & Poth, 2017). This is a methodical investigation into complex reality in unstructured environments. These occurrences may include, but are not restricted to, how people perceive different facets of their lives, how people behave individually or in groups, how businesses run, and how interactions affect social interactions. According to Denzin & Lincoln (2011), qualitative research has several facets and employs an interpretative, normative approach to its subject. The complexity of qualitative research allows for the development of a comprehensive image of the analyzed phenomenon.

The qualitative research exhibits the qualities listed below, in brief (Leedy & Ormrod, 2010):

- Qualitative research is comprehensive; it considers the bigger picture and starts with an effort to understand the entire.
- Qualitative research examines how different parts of a system interact.
- Qualitative research doesn't always aim to make predictions about a specific social situation; instead, it focuses on understanding it.
- Qualitative research necessitates a labor-intensive and continual data analysis process.
- The researcher must become the research tool in qualitative research design. It includes space for the researcher to describe their personal biases and ideological preferences.
- The design of qualitative research takes into account considerations about informed consent and is sensitive to ethical issues.

Instead of trying to explain anything, exploratory and descriptive research aims to do (Leedy & Ormrod, 2010). The descriptive aspect of qualitative research enables the researcher to give an account of the participants' experiences that will either support or contradict the theoretical presumptions underpinning the study. Readers can comprehend the significance associated with the experience, the unique nature of the problem, and the impact of the issue, thanks to the descriptive quality of qualitative research (Leedy & Ormrod, 2010)

3.5. Data production instruments

3.5.1. Participants Profile

The focal point of this research is based on Grade 9 Technology teachers in South African public schools in the Gauteng province. The reason for choosing grade 9 is because in South African

schools, grade 9 is the last grade in the General Education Training phase (GET), therefore it is significant to analyze and determine if learners are being supported and educated with appropriate skills according to the expectations of the upcoming industrial revolution as they move to the higher grades. The method called purposive sampling was used. Purposive sampling is a non-probability sampling method in which the researcher relies on participants' own judgements (according to the need of the study), when choosing respondents that participated in the research. Purposive sampling is a sampling strategy used by qualitative researchers to choose individuals who can offer in-depth and comprehensive information on the topic under study. This kind of sampling is specific to a certain group of participants, is frequently used in qualitative research to find and choose information-rich instances associated with the topic of interest and the advantage of using it lies in the fact that findings may be based on exactly what the research seek to investigate (Palinkas, Green, Wisdom & Hoagwood, 2013).

By reducing the possibility of selection bias and controlling for the potential impact of known and unknown confounders, probabilistic or random sampling, in contrast, ensures the generalizability of findings. In this study, only Ten Grade 9 Technology teachers were requested to participate in the research because they are relevant to the study. As Palinkas, Green, Wisdom & Hoagwood (2013) observe, sampling procedures are designed to maximize effectiveness and validity regardless of whether the methodology used is quantitative or qualitative. However, sampling must be in line with the objectives and presumptions that underlie the use of either approach. The main goal of qualitative methods is to obtain depth of understanding, whereas the main goal of quantitative approaches is to achieve breadth of comprehension.

3.5.2. Data Collection Techniques

Paradis, O'Brien, Nimmon, Bandiera & Martimianakis (2016) suggests that data collected through interviews should be collected by recordings and was transcribed. Exact words of the participants are of paramount importance in any research as they help detect themes in their responses received during data collection phase. Monday (2020) perceives an interview a discussion between a number of individuals about a subject of shared interest that stresses the social context of research data and underlines the importance of human engagement for knowledge production. Doody & Noonan (2013) cited the following several factors as the reasons of using interview:

- the demand for highly tailored data.
- the necessity for possibilities for probing.

- It's crucial to have a high return rate.
- The respondents either struggle with written language or do not speak the country's native tongue well.

To answer specified research questions, test hypotheses, and assess results, data collection is the act of acquiring and analyzing measuring information on targeted variables in a systematic and defined manner, (Kabir, 2016). The aim of any data collecting is to gather high-quality evidence, which can then be used to conduct extensive data analysis and create a solid case for answering a given question. Accurate data collecting is crucial to preserving the integrity of research, regardless of the subject of study or preferred method for defining data (qualitative, quantitative). In addition, this method ensured that the data collected is reliable and accurate. Therefore, in this research, the data was collected from each participant through semi-structured interviews by the use of an audio recorder and was later transcribed for record and reference purposes. Due to the current pandemic of COVID-19, and by conforming to the restrictions, there were no observations in classrooms. Limitations were brought about by this study as it focuses more on teachers without the involvement of Higher Institution as part of the participants. However, the impact of Higher Institutions on the knowledge of in-service teachers was acknowledged.

3.6. Case study

This research accounted for a case study. According to Yin (2013) a case study research design looks into a phenomenon in its actual context, taking into consideration boundaries associated with it. Sturman (1997) perceives a case study as a broad word for the investigation of a person, a group, or a phenomenon. Therefore, a case study is an in-depth account of a specific instance and its analysis, such as the description of the instance and the events as well as an explanation of how these qualities were discovered, which is the research process itself. According to Flyvbjerg (2011) a case study is used when we analyze and describe something in detail, such as each person individually (their action, special needs, life circumstance, personal history, etc.), a collection of individuals (a school division, a collective of students with special needs, school staff, etc.), an issue (or several problems), procedure, phenomenon, or event in a specific establishment, etc. This study looks at the real-life events in a natural and real-life context. Case studies can be used to examine, explain, or characterize occurrences or phenomena in their natural environments, (Yin, 2013). It lies in the realistic factor that findings of the study are accurate and reliable. The purpose of a case study was used to create an in-depth of each one of the participants, considering differences and similarities that lies in their scenarios.

Because case study is concerned with the intricacy and unique aspect of the case in question, it can be thought of as an account of an action, occurrence, or problem. A case research dwells on personal experience and context, and it emphasizes the fact that research would not be relevant and accurate enough if the setting was altered with the intention of reaching a certain goal. Research is research because of the authentic state in findings.

In the case of this study, participants interviewed were not expected to come from the same state of context. Participants came from different public schools which differs in terms of resources and ways of teaching and learning. It is in the differences that lie between participants that encourages realness and trustworthy of findings. This study is supported and outlined according to the theory of case studies, as it takes into consideration different experiences and context different teachers may originate from. Experiences that each one of the participants encountered, of which may be totally different from each other, plays a big role in substantializing the nature of this study. This is due to the fact that this study looks at the subjective views of the participants. It considers personal experience, rather than the science route that it entirely bias. Science is based on findings that came about as a result of a certain procedures and it generalizes. It assumes the experiences of an individual by generalizing with the experiences of the society. This is totally against the nature of this study.

3.7. Data analysis

Data is not reliable data without it being analysed, interpreted, understood, evaluated and examined. The process of cleansing, converting, and modeling data in order to find relevant information for effective decision is known as data analysis. Extracting usable insights from data and making decisions based on that analysis are the goals of data analysis. Thorne (2000) describes data analysis as the most important section of the research because it contributes notably to the conclusion of the research. Likewise, Thorne (2000) suggests that an in-depth method of data analysis is called qualitative data analysis, whereby, instead of using statistics and mathematical graphs, data can be broken down into smaller pieces and a pattern can be followed according to the responses of the participants (content analysis). In order to communicate a narrative or solve a problem, researchers significantly rely on data. Data is nothing more than the response to the inquiry that comes first.

Therefore, this research adopted qualitative data analysis approach as it seeks to produce quality work, rather than work based on quantity. In addition, data was analysed thematically. We refer to the supplied data as qualitative when there are words and descriptions included. Although this data can be observed, it is more difficult to compare and more subjective to examine in research. Open-ended survey questions or focus groups, as well as individual interviews, are frequently used to gather this kind of information. According to Aspers & Corte (2019), any information that may be recorded but is not mathematical in nature, that is, not quantifiable data, is referred to as qualitative data. This is typically done by contrasting qualitative data with quantitative data and defining it through distinctions. As a result, the distinction between words and numbers is frequently perceived as one. However, even words may be tallied and quantified, and interpretations may be made based on their frequency or absence. As a result, the split is not distinct. One characteristic of qualitative data is that it usually consists of either textual, vocal, auditory, or visual data that may be interpreted and described rather than measured.

Furthermore, to understand research concepts, this research followed an inductive reasoning approach. Matzel, & Sauce (2017) perceive inductive reasoning as a philosophical procedure whereby several premises, which are all generally accepted to be true or to be true, are integrated to arrive at a certain conclusion or to provide support for the veracity of a conclusion. To produce predictions or projections, inductive reasoning is frequently used. Inductive reasoning varies from deductive reasoning in that the truth of an inductive inference's result is only probable, whereas the latter's conclusion is certain. The degree of certainty is determined by the strength (or consistency) of the evidence. This study is align with inductive reasoning as conclusions and interpretation of data (according to its pattern) was based on evidence, it was not assumed beforehand. It can never be assumed that the knowledge and the preparations for 4IR are the same in all the schools of different environments. Hence, it remains paramount that conclusions are based on findings of the research.

Due to the interpretive nature of this research, it depended on participants and their experiences which led to the discovery of a reliable theory. Albuquerque, Lucena & Freitas Lins Neto (2014) describe research participants as those who take part in the research, to share the information which may in most cases be personal. In this case, research participants are selected through two methods: purposive sampling method and a random sampling method (Patel, Doku & Tennakoon, 2003). The decision on which method to select lies in the data that a researcher seek

to attain. The purposive sampling method represents the target population, whereas the random sampling method randomly selects participants to meet size and power requirements.

A purposive sampling method was adopted in this research and was grade and subject specific. Only grade 9 Technology teachers took part in this research, as information that they provided was the most reliable because they shared their experiences. As a result, this selection method represented the target population.

3.8. Ethical considerations

Ethics were observed during data gathering for this research study. The intended participants are schoolteachers that served as respondents. The ethics application was submitted to the University's Human Research and Ethics Committee, approval was granted (see appendix A). Thereafter, the participants received independent declarations and non-disclosure/confidentiality consent forms to sign. These forms were signed before information was collected so as to offer legal protection should there be any harmful information leaks. In addition, the researcher fully explained the purpose of gathering the data to the respondents and assured them that their responses were kept confidential and/or anonymous. The Gauteng Department of Education received a request to participate in interviews at schools (see appendix B).

In general, trust worthiness refers to the extent to which someone or something can be trusted. In this case, trustworthiness considers the extent to which data itself can be classified as reliable and be trusted. This depends on the methods applied when conducting the research, which included research design, data collection and data analysis, despite any challenges. Anney (2014) explains that "…..qualitative researchers consider that dependability, credibility and confirmability as trustworthiness criteria ensure rigor of qualitative findings". Credibility considers the confidence in the truth of the findings, whereby a qualitative researcher can consider peer examination, triangulation (use different methods such as interviews and observations), time sampling, etc. Confirmability refers to the extent to which findings can be confirmed by other researchers; and dependability refers to the extent to which findings are stable over time (Anney, 2014).

In this study, data collected was analysed according to its exact nature, without the bias influence of the researcher's interest or preferences. Participants were selected according to their in-service experience. This is to ensure that data is reliable as teacher were expected to have a good idea of what they are being interviewed about.

Conclusion

This Chapter described the methodology of the study, including the steps used to choose the participants, the technique utilized to gather data, and the strategy employed in text analysis. In order to illustrate one way in which the concepts under examination are formed by a grade 9 Technology instructor, the purpose of this study was to analyze preparations that may or may not take place in Grade 9 Technology subject for the 4IR. The analysis process is described in detail and the research's findings are discussed in the next Chapter.

Chapter Four: Data presentation, analysis and interpretation

4.1. Introduction

This chapter firstly presents, analyzes and finally interprets data collected from teachers concerning their preparedness in teaching learners for the 4IR in their teaching practice. As mentioned in the above chapter, data was collected by recording through one on one interviews with ten grade 9 Technology teachers. Recorded responses were then transcribed to make it easy to be presented, analyzed and interpreted.

4.2. Data Presentation

Thody (2006) asserts that data presentation in qualitative research communicates to the research location. This establishes the framework that will enable the reader to interact with and watch people being researched via the writer. Furthermore, it generates a detailed depiction of facts and reality, with the intension of making the study reliable. Data can be presented in various formats, such as a table, graph, text, and so on, in a qualitative study so that logical conclusions can be drawn from the gathered information.

Technology is a practical subject and need to be taught using concrete concepts where learners will have a look at what is happening and apply the learned concepts. Data was collected through interviews from 5 schools with 2 participants from each school giving a total sum of 10 participants. To protect the respondents' anonymity, the interviews were quoted verbatim. The first school where data was collected was code named as SA, second school was code named SB, and so on. The first teacher from the first School were pseudo named AT#1 (first teacher from school A), the second was pseudo named AT#2 (second teacher from school A), The first teacher from the second school were pseudo named BT#1 (first teacher from school B), the second was pseudo named BT#2 (second teacher from school B), and so on (See Table 2). The interviews were conducted at times and places convenient to them. All the teachers interviewed agreed to be audio recorded to ensure accurate capturing of the data.

Table 2: Schools and Teachers Pseudo names

School Pseudo name	Teacher Pseudo name
SA	AT#1
	AT#2
SB	BT#1
	BT#2
SC	CT#1
	CT#2
SD	DT#1
	DT#2
SE	ET#1
	ET#2

The interviews were conducted to answer the following sub-research questions

1. What methods of teaching do Technology teachers practice, that prepare learners for the 4IR?
2. What are the 4IR skills that Technology teachers should impart to learners?
3. Why there is a slow uptake among Technology teachers in embracing technology in their teaching practice to prepare learners to meet the needs of the 4IR?
4. How do Technology teachers envision ideal ways of preparing learners for the 4IR terrain?

These research questions are attempted to address the problem at hand which is the failure of most teachers to prepare learners for the 4IR. Moll (2021) perceives the 4IR as the fusion of digitals, artificial intelligence, technologies, etc., of which will shy away from the 'ordinary' means of living, such as manually operating a machine, physical contact in the classroom (for teaching and learning), and so on. In this case, the society needs to adopt required skills in order to be able to survive in 4IR, skills such as being able to operate digitals and technologies of the 4IR. The shift to this revolution is vital in the educational sectors. This is because the education system is identified as the source of transformation to the society. Content or concepts taught in the classroom shape up the mind of the individuals and therefore affect how the perceive the process of living in the society.

Teachers play a huge role in shaping up the society, and through education, skills required for the 4IR can be transferred to the society to prepare learners for this revolution and its workplace. Teachers seem not be fully equipped with the knowledge of the 4IR skills, let alone applying these skills to help prepare learners for this revolution. Technology as a subject plays a huge role in the society as it gives learners the actual experience of the outside world, it requires practice and application of the knowledge and skills, such as problem solving and the designing process. Mtshali, Ramaligela & Makgato (2020) argue that in South African public schools, the Technology subject has been neglected in terms of integrating it with Information Computer Technology (ICT) during teaching, and this is due to lack of knowledge of applying ICT, lack of knowledge of integrating ICT with Technology concepts and even the lack of ICT resources in the school.

The data obtained from the participants were presented in this chapter. The categories identified include: 'Teaching resources and pedagogy', '4IR knowledge among teachers and their perceptions', 'lack of knowledge and professional growth in digital space', 'the future of 4IR in teaching technology' and 'the digital affordances that 4IR provides'. As the categories were presented, the researcher analysed data presentation in order to determine themes that emerged.

4.2.1. Teaching resources and Pedagogy

A basic lesson includes the use of teaching resources to present concepts in a more understandable way, such as visuals using a digital projector, and methods to be used when presenting these concepts. Muratova & Abraimova (2020) perceive teaching methods and resources as the core of the lesson. Teaching resources and methods actually aid learner-understanding of the concepts, and some methods make sure to keep learners engaged in the lesson. This simply encourages learning to take place in the classroom.

The Technology CAPS Document (Technology, CAPS, 2006) mentions that Technology as a subject was introduced into the South African curriculum in recognition of the need to produce engineers, technicians and artisans needed in modern society and the need to develop a technologically literate population for the modern world. This tells us that Technology is more practical than theoretical, it is associated with the application of skills (such as the designing process and problem solving) and acquiring these skills to produce a technology literate

individual. In order to succeed this, teaching resources and methods that can keep learners active and engaged can be used, such as making projects, designing, and so on. However, due to the current Fourth industrial revolution that is emerging, it is a necessity for teachers to conform the shift by applying teaching resources and methods such as ICT, in order to promote the skills of the 4IR and prepare learners.

The phenomenon of 'pedagogy' is regarded as one that sums up practice occurring in a classroom in relation to content. "Pedagogy in educational vernacular has gained currency as a substitute for methods of instruction or techniques of teaching" (Cuenca, 2010). Pedagogy can be identified as the backbone of a lesson. If appropriate resources and methods are used to deliver content, the lesson becomes successful. It is an undeniable truth that times change, over time, certain strategy become outdated as new strategy are being introduced. As we are currently shift to the 4IR, some individuals already practice new ways of the 4IR such as holding online conferences instead of physically filling up a hall, however, some are stuck in the old ways of living manually. For example, in the 1990s, hardcopy academic books were found to be more effective, as years went by, technology was introduced, and many things moved towards the online and technology route. Nowadays, people visit websites and download softcopy books to do some readings, and they find this strategy more effective. Gudmundsdottir & Shulman (1987) emphasized the importance of having pedagogical content knowledge as a teacher. Pedagogical content knowledge (PCK) is referred to as a blending of content knowledge and pedagogical knowledge in presenting a particular topic or concept, (Segall, 2004). This simply shows the importance of the knowledge of teaching resources and methods, in relation to the context and content.

The knowledge of teaching resources and methods is vital, so as to align with contemporary resources that pupils experience in their everyday lives. It may not raise pupils' interest to apply the textbook teaching methods as pupils nowadays prefer being practical and engage in everything that they do. For example, in 2020, COVID-19 plugged the whole world. South Africa went to lockdown, and normal (in contact) teaching and learning was practiced for a while. The COVID-19 epidemic made it clear that technical proficiency was necessary, and educational life, from primary and secondary education to higher education, will be the ideal setting for this achievement. Schools that had technological resources quickly switched to remote teaching emergency in order to keep up with the curriculum. Most public schools were left behind in terms of the Assessment Teaching Plan (ATP) due to the lack of means to deliver content online. This

was merely because of the lack of technological resources in schools. This lack of technological resources affected teachers during COVID times and even before. This was evidenced by the remarks made by BT#1, who mentioned:

> *When it comes to this subject of ours (Technology) and the limited resources that we have, we usually use textbooks and some of the previous question papers. In all honesty, we don't really have much. We don't have technological resources to use, such as computers and digital projectors to demonstrate visually how certain concepts are developed. We are a poor school. Methods I have been applying during lessons are mostly teacher-centred because I avoid wasting time on content that might not be covered by the CAPS Document. I want my learners to take down notes while I am teaching and use previous question papers for practice.*

Notably, BT#1 points out that there are not enough resources to use during lessons, of which may hinder progress to presenting content to the understanding of learners. This teacher still uses and old method of reading a textbook and referring learners to previous question papers for practice. Learners are not encouraged to learn and understand concepts in any ways. Reason being is that even though there no technological resources available in the school, the teacher does not make exceptions of creating manual visual resources that could catch learners' interest, such as colourful charts and models. Generally, Technology subject includes a lot of structures and steps that are likely impossible to be explained or taught in abstract. Learners need to visual the structure developed and be engaged in the lesson by practically applying skills learnt. In this case, BT#1 seem to be focused more on covering CAPS than making sure that learners understand concepts because no extra effort is put when it comes to compiling more useful and interesting resources. Learners are not taught using resources they are more familiar with and therefore will not even gain interest in grasping concepts.

A similar comment was made by BT#2 who mentioned that:

> *As a grade 9 technology teacher, I prefer using practical activities and group discussions so that learners get to share different ideas. However, I make sure to stick to the textbook when teaching because it contains perfectly 49bsence49ri content and pictures used are very clear for learners to*

understand. I also use previous question papers to prepare learners for their exams. Unfortunately, we do not technological resources in our school. We only have a printer in the admin office that we use to make copies of the previous question papers.

BT#2 seem to have an idea of how important it is engage learners in the lesson, and from this statement, one can tell that the method that BT#2 apply in the classroom is learner-centred as learners are given a chance to share their own views of the concepts and be practically involved in the lesson. However, there are still no technological resources available, of which may still not meet the interest of learners as they are more familiar with technology and will understand better through it.

The common factor lies in the limited resources that are used in the classroom. Regardless of the limited resources, it lies the teacher's PCK (Pedagogical Content Knowledge) to utilize resources available to create a space that promotes learning. The SB school seem to have limited resources, and this obviously affects learning in the classroom. Techers use whichever resources presented to them to teach, however, they still perceive teaching in different way. BT#1 sees teaching as standing in from of class and provide learners with content. According to BT#1, this method is believed to be a success as learners are being taught all the content covered in the CAPS. In contrast, BT#2 sees teaching as supposed to be a two-way street. Learners can learn from the teacher and can also learn from each other. Even though there is an absence of technological resources, BT#2 tries to encourage learning by engaging learners in the subject. To some extent, BT#2's comment aligns with that of DT#1 which was captured as follows:

Methods that I use are learner centred, because as teachers we try to focus more on what learners already know, what they are able to do, how can they learn and what might be their barriers to learning. Including learners fully in the lesson helps to track their understanding of concepts. When it comes to resources, it is typical resources like projectors and tablets, and as a teacher I have my own laptop provided by the school. The learners are also allowed to bring their devices to school. So most teachers including myself make use of Whatsapp groups to stay in touch and maybe send learners work when they are at home.

Both BT#2 and DT#1 encourage learner inclusivity in the lesson. They believe this method is more suitable as they are able to promote learning and participation, as they main focus is to

observe and monitor learners' progress of the understanding of concepts which shows their understanding of the concepts, other than through writing during formal assessments. DT#1 seem to be in a more resourced school as there are ICT resources and utilize other forms of communication with learners, such as WhatsApp. In this WhatsApp platform, multimedia can be shared with learners, and because learners use this application in the everyday lives and they are very familiar with, this will encourage them to be more active by participating and completing activities. Though there are not many resources to be used during the lesson, except for a chalkboard and textbooks, AT#1 also believes in the method of putting learners as the centre of the lesson, however, teachers should also take part in the lesson. AT#51bsencened:

> *When it comes to the method, it depends on the topic I am teaching that day. Sometimes I'd use a learner centred method and sometimes I'd use a teacher centred method where learners will focus on what I am saying and teaching. With the learner centred method, learners will group themselves in groups of 5 or 6 and they will engage and discuss and try to solve the problem on their own and then I'll just move around and facilitate. We don't really have much, we just use a chalk board and textbooks only.*

AT#1 emphasizes the importance of a mutualistic relationship between the teacher and learners during lessons. Furthermore, AT#1 mention the importance of grouping learners so that they can share ideas of the content. It is clear that the approach of putting learners as the centre of the lesson works for most teachers. It is believed that for learners to acquire a concept, they have to discuss their views of it, correct each, and most importantly, learn from each other. Although there are no technological resources available in AT#1's school, but the inclusion of learners in the lesson has been made a substitution that is, in this case, found to be productive.

It can already be concluded that teachers in general, teachers have their own preferred ways of presenting content and methods to use during lessons, though it may be based on the availability of resources in the school. A successful lesson depends on resources and methods, which may promote learning in the classroom.

4.2.2. 4IR knowledge among teachers and their perceptions

Transitions occur in our societies over time. This includes systems used to maintain the society as a whole, such as having access to information on what is happening around the world, means of communication, transportation, purchasing of goods, exchange of good and services around the world, the education system, and so on. Schwab (2017) refers to the current transition in the

society as the Fourth Industrial Revolution (4IR). The 4IR is 52bsence52rized by the digital transformation that pervasively impacts every work of life across the globe, of which was a missing aspect in all the previous three industrial revolution that mostly required direct and physical contact with a system in order to achieve a certain goal.

As the shift from one industrial revolution to another occurs, the education system also develops, in terms of new methods and resources are introduced. The 4IR is indeed beneficial to those who already equipped with required skills for it, such as computational skills, coding skills, etc. It becomes a disadvantage to teachers and pupils who are not well equipped with 4IR skills as it would be difficult to navigate in the society during this era. Though the main purpose of the 4IR is to develop the education system and produce people who will perfectly fit in the 4IR workplace, it may be a challenge to learners who are being taught by teachers who are not well knowledgeable with 4IR.

In general, people of the society have different views of the 4IR. Teacher DT#2 is of the opinion that the environment they are working in does not promote teaching using digital tools as there are absolutely 52bsence of such tools in schools.

> *We are still stuck in the classrooms with textbooks from five to ten years back. No new resources are being introduced in my school. I do not foresee the 4ir taking place anytime soon in our country as we are still left behind as a country. I mean, there is a high percentage of youth unemployment. How then will the government afford to introduce the 4ir and all the technological resources if they still fail to create jobs for the youth.*

According to the Teacher DT#2's view, there is still a lot that the government needs to fulfil. As a developing country, it seems impossible to completely shift to the 4ir as the country is not equipped enough with resources and processes of the 4ir. This is to include resources such as ICT devices, developed software, the knowledge itself of ICT, and so on. Teacher CT#1 finds it difficult or impossible to teach learners using the 4IR requirement skills required by the 4IR as the societies they are working in are not near any digitilisation

> *In a perfect world, yes, the 4ir would take place. Our lives would be much easier and faster. The fourth industrial revolution is associated with digital approaches of living. This includes the use of robots, online platforms for teaching and working, etc. Considering the fact that during lockdown, most schools had to put everything on hold, they could not hold any classes. Our*

country is a little bit left behind with regards to the development of the economy. It would be a challenge to introduce the 4ir system while societies themselves are not well equipped.

Although Teacher CT#1 perceive 4ir as being unrealistic, however, what can be drawn from their response is they are aware of the shift from the 3ir to the 4ir, it is just that in a developing country such as South Africa, it looks impossible. Another strong was made by Teacher CT#2 to the negative impact this era could bring to the society.

To me, the 4ir is there to sabotage human labour abilities because during time, devices such as robots will be introduced. Learners will be taught by robots and automated systems, therefore, this could put teacher at risk. Teachers will definitely loose their jobs. In general, I am for the main reason for the shift, the issue lies where people in the society end up losing their jobs. The bottom line is the 4ir will develop the economy but will increase unemployment.

In contrast to the above views, Teacher AT#2 perceives 4ir as a possible breakthrough of the country. This may be a chance for South Africa to grow economically.

Growth and development take place if change is allowed to happen. Many societies are afraid of change, they become too comfortable with their current system. How is one then expected to grow if they do not allow change? The 4ir is the possible bridge to development and growth of the society. Look at how South African schools are left behind in terms of their education system. They do not even have an learning management systems to conduct blended learning. Honestly, I am for the 4ir. I cannot wait for the shift as I foresee breakthrough in our country.

It is undeniable to change occurs overtime. In most cases, change is meant of bring development. With regards to the 4ir, as much as it is believed to bring development, most societies foresee increase in unemployment.

4.2.3. Lack of knowledge and professional growth in digital space

Application of technology requires knowledge of Technology itself. This is what Shulman (1986) refer to as Pedagogical content knowledge (PCK). It is significant for a teacher to acquire adequate knowledge of resources and teaching methods they are

willing to apply in their classrooms, in relation to content. With regards to technology, teacher can be able to make use of it during lessons, to enhance understanding of concepts. However, for this to succeed, a teacher has to have knowledge of applying technology itself so as to use relevant technology resources which may be effective in presenting that particular concept.

Considering the fact that some teachers are veterans, they obtained their qualifications more than 20 years ago. The education system at that time was a little bit different from the present one. Technological resources were barely used, technology was even not emphasised as it is now. This did not expose teachers to technology; hence, most veteran teachers are unable to make use of technology and do not necessarily support and see the importance of using technological resources in the classroom.

HT#1 admits the effectiveness of integrating technology during lessons. However, it lies in the knowledge of the teacher to use these technology resources.

> *Personally, I have not been exposed to technology when I was studying towards my teaching diploma. My school is fully equipped with technology resources; however, it is quite challenging for me to make use them as I cannot operate them. I even struggle when I have to type a text message on my smartphone, how much more with technology teaching resources (giggles). On the other hand, I believe that technology would make a great difference in enhancing teaching and learning as learners are exposed to it already and will definitely appreciate using them during lessons. This will therefore prepare learners for the 4IR.*

Unlike HT#1 who is for the application of technology resources in preparing learners for the 4IR, HT#2 perceives the use of technology in the classroom as not as effective. This is due to preceding teaching methods that were being used all along, and do not see any need to introduce technology to the education system.

> *I see no need to introduce technology resources when teaching Technology. The reasons I am say this are: some of us teachers have not being exposed to digital technology before, we do not have knowledge of the application of technology resources. Secondly, I feel comfortable applying teaching methods I always use in the classroom, which include the use of textbooks, charts and models. My learners have been doing very well with these methods and I*

believe they are the most effective.

The bottom line is most teachers do not embrace technology because they lack knowledge of technology and its application, and this is the main factor that delays the uptake of Technology teachers in embracing technology resources to prepare learners for the 4IR. Both teachers (HT#1 and HT#2) emphasise that they are do not apply technology resources in their classrooms because they do not have adequate knowledge of technology. It could be a challenge for these teachers to integrate technology with content as they would not be able to use relevant technology content in a particular concept. For example, instead of using visuals and emotions to show different types of forces, the teacher could use an audio explaining this concept. This could be ineffective as learners need to see the actual movement of forces when they are applied.

> *It is very sad for teachers like me because even though I have the knowledge of technology resources, but I am unable to make use of it. This is due to lack of technology resources in the school. What is saddening the most is that my learners miss the opportunity to prepare themselves for the 4IR. It would have been great to take all my lessons to a digital space of which will prepare learners for a digital workplace of the 4IR.*

Well, not all Technology teachers are unable to apply technology resources during lessons lack knowledge of these resources, however, some get limited by the availability of these resources in the school. JT#2 feels limited by the school as he has got knowledge of technology resources, but his school is not well resourced. With this being said, lack of knowledge of technology resources is not only the factor that hinders learners from being prepared for the 4IR, lack of resources themselves also play a huge role.

4.2.4. The future of 4IR in teaching technology

The role of a teacher is of paramount importance in the society. This is because it is through the teacher that knowledge and skills are transferred to the society. 4IR skills such as artificial intelligence, robotics, analytical thinking, etc., are transferred through formal education, and it is up to the teacher to effectively deliver these skills. As we approach the 4IR, adjustments in the society are necessary to take place so as to prepare for the 4IR. These adjustments include changing of societal systems, introduction of new skills and knowledge, change in the workplaces, etc.

The nature of Technology as a subject requires mostly practice and application of

knowledge and skills. According to the Technology CAPS document, the Technology subject stimulates learners to be innovated and develops their creativity and critical thinking skills. JT#2 claims that 4IR skills can effectively be delivered to learners in the Technology subject through the integration of technology.

> *The future of 4IR seem to be very successful as teaching and learning is done with an integration of technology. Technology subject can be taught using technology by including audios, visuals, digital models, digital operating systems, etc. This will definitely prepare learners for the 4IR workplace. I strongly believe that the successful future of 4IR lies in the integration and introduction of technology resources in subjects such as Technology*

Contemporary teaching seems to be more effective as it exposes learners to ways of learning that they are familiar with. JT#1 supports this statement as he believes that the use of technology resources such as tablets, whiteboards, etc., successfully prepare learners for the digital space of the 4IR.

> *Right now, we use a lot of technology. We have smartphones, laptops and we can also use projectors in class. If we can have those resources, we can adapt to new ways of learning and teaching. Making use of YouTube videos, and Google while teaching enhances content value and transfers digital skills to learners which will be an advantage in the 4IR.*

Digital technologies seem to be a common component that could promote 4IR skills in the classroom. However, AT#1 pointed out challenges that may arise in the midst of preparing learning for the 4IR. This is due to the inequality in the society itself, of which may be hardly possible to change.

> *I totally believe that Technology subject can be taught effectively with the use of technology resources, and this will help prepare learners for the future (4IR). The challenge that may arise is that of availability of resources. Lack of technology resources in some schools may hinder the process of preparing learners for the 4IR. This is totally out of teachers' hands as they may end up sticking to the old ways of teaching and fail to introduce 4IR skills.*

The future of 4IR lies in the extent to which preparations are properly done at this presence. Teaching Technology as a subject could be done with the help of technology resources that can keep content practical, allow learners to engage in the lesson and develop digital technology skills. It is indeed vital that the future of 4IR is being prepared

for.

4.2.5. The digital affordances that 4IR provides

Though digital technology does not change education itself, it however enhances its application. This is referred to as affordances. The 4IR is bringing a lot of convenient digital affordances to the societies. These affordances simply provides advantageous features that are aligned with the nature of 4IR. According to Melville & Robert (2020), one of the affordances that stand out is that of being cyber-physical. Most systems, such as the education systems, banking systems, marketing systems, etc., will be entirely online. This is the aspect of 4IR that JT#2 strongly believe is a digital affordance of 4IR.

> *Taking education to an online space would be an advantage, to us as teachers and to our learners. This give learners a warm platform of learning, whereby they are able to get access to any kind of knowledge and can also engage with peers online. The affordance of 4IR bringing online systems is very important and will conveniently assist learners understand concepts.*

Another digital affordance pointed out by ET#2 is that of time. Time is regarded as a crucial component in education as most teachers struggle to keep up with time stipulated. In the education system, content delivery is being sectioned and planned, in terms of the amount of time to be spent on a certain concept.

> *I believe that time would be easly manageable during the 4IR, in term of teaching and learning. The amount of time wasted in the classrooms is out of this world. Personally, I avoid writing notes and drawing diagrams in the board because it wastes a lot of time. Taking education to an online platform would definitely save time because of multimedia and other digital resources available online.*

Most teachers teach according to a document that was introduced by the department of education, called the CAPS document. This document time teachers on the amount of content to be covered at a certain period of time. This also helps teachers dedicate a certain period of time on a particular content appropriately. For instance, each chapter can be allocated teaching time according to its length. ET#2 perceives digital technology as the solution to keeping up with the CAPS document.

Time will no longer be wasted on activities such as the writing of notes on the blackboard, but learners can access multimodal content easily and conveniently.

4.3. Data Analysis

There are a lot of different approaches of analyzing data. There is no one way to do it. Savin-Baden & Howell-Major (2013) describe data analysis as breaking parts into meaningful parts, as making sense of the data or systematic search for meaning. It does not matter what the data is. It might be semi structured interview, focus groups, diaries, documents, etc. The basic process is going to be the same for all of them. Analysis of qualitative data comes down to reading it very close detail, familiarize yourself with every nuance of data and all the different methods of analyzing qualitative data.

In some ways, the analysis of qualitative data is a lot like writing a book report you would summarize the plot, you would describe the characters, what they do and motivations, and the themes that may exist in the book. The report that you write about the book is going to be shorter than the book itself, but it gives an idea of what the book is all about. The challenge with qualitative data is not the volume, it is the depth of the data. It contains a lot of context and experiences, to try and explain and describe the data. It follows a particular structure.

The chapter started off by describing what was discovered during data collection. This section presents data analysis. The chapter extracted the most important findings. The research explored how Grade 9 technology teachers prepare students for the 4IR in their classrooms. The data findings were analysed thematically. Thematic analysis is a powerful yet adaptable tool for assessing qualitative data that can be applied in a range of paradigmatic or epistemological frameworks. When attempting to comprehend experiences, thoughts, or behaviors throughout a data set, thematic analysis is an appropriate way of analysis. Thematic analysis is not restricted to a single paradigm; rather, it may be employed in post-positivist, constructivist, or critical realist research methodologies (Braun & Clarke, 2006). Many interpretivist orientations (e.g., constructivism) emphasize the social, cultural, and structural contexts that influence individual experiences, allowing the development of knowledge that is constructed through interactions between the researcher and the research participants, revealing socially constructed meanings (Braun & Clarke, 2006). According to Braun & Clarke (2006), a theme is a "patterned response or meaning" obtained from the data that sheds light on the study topic. A theme is a more abstract

concept that requires more data interpretation and integration as compared to a category, which describes and organizes the "manifest content" of a data collection (Nowell, Norris, White & Moules, 2017). No matter how many times a concept or item connected to a theme appears in a data collection, researchers may still find themes by using thematic analysis. In this study the main themes that are emerged are:

- Teaching resources and Pedagogy;
- Conditions of the school environment; and
- Lack of knowledge of using digital tools-4th IR

The key goal of this section is to sort through the results and identify which ideas are new and repeated frequently. Along with the interpretation, it refers to what was reported in the literature review and discusses how the study's findings differ from it (re-integration). In order to assess the degree to which Grade 9 teachers have adequately prepared their students for the 4IR landscape, the major themes are examined.

According to reports, the 4IR will introduce digital and technology viewpoints to social processes and operations (such as communication, marketing, education, and trade, among others). The education system stands out because it has a significant impact on how society is shaped and set. The world transforms as a result of education, claim (Oakes, Lipton, Anderson & Stillman, 2018). The society's outlook is altered by it. In this scenario, education is seen as the ideal platform for the transformation because the 4IR aim to make society more digital.

Theme 1: Teaching resources and Pedagogy

The concept of teaching resources and pedagogy appeared very strongly from the respondents. According to current requirements and educational system characteristics, the connection between digital education tools and teachers' knowledge of how to use technology in the classroom contributes significantly to students' key competencies (Makarova & Makarova, 2019). The current education system is being disrupted from its current way of doing things in order to meet the needs of an era that uses technology and artificial intelligence in business. Teaching methods and tools must evolve to meet the demands of the modern environment that is characterized by using digital tools for learning. Methods for incorporating technology as a subject in the classroom are critical. This is because these methods determine the extent to which skills and values aligned with the needs of the society will be introduced and passed. Some of this skills and values could

be computational thinking, problem solving, robotics, and so on. In 21st century, new methods of teaching that are driven by use of digital technologies are very much needed to be introduced as it demands new and different abilities.

Education is affected by the growing impact of various media, particularly television, the internet, and online communication, as well as by the rapid advancement of science and technology. This is among the causes why today's students, as opposed those who attended school twenty or even a decade ago, have various interests, priorities, and opinions about education and the teaching approaches. They seek out learning that is exciting, novel, and engaging, like the image data on television or websites. Prior to the rapid advancement of technology, the teaching method was limited to the teacher's oral presentation of material and writing on the blackboard with chalk. Although speaking remains the most invaluable attribute in the teacher's job, it is difficult to imagine today's teaching process without the use of various modern instructional and learning tools. Their use enhances the learning process and makes it more engaging, current, and attractive. Most significantly, though, it helps teachers organize and carry out the learning process effectively while assisting students in developing their cognitive and emotional capacities.

Voogt & Roblin (2010) mention that knowledge construction, adaptability, critical thinking, information management, and other 21st-century skills, by definition, necessitate new and more effective methods of acquisition and application. Taking into consideration the extent to which learners of the 21st century are exposed to the digital world, it is highly impossible that they find traditional teaching methods effective. Likewise, participants in this study demonstrated that their teaching is still predominantly characterized by the use of chalk and texbooks (traditionally), and accompanied by lack of digital technology resources. Traditional teaching methods are regarded as those that entirely uses hardcopies in form of books and charts, which are completely analog (Dimitrios, Labros, Nikolaos, Koutiva, & Athanasios, 2013).

Teaching practice is composed of several aspects such knowledge of the content, knowledge of teaching methods and knowledge of teaching resources. This is what Shulman (1986) refers to as PCK (pedagogical content knowledge). The way in which content is delivered is influenced by PCK, and this is aligned with objectives that a particular lesson has. Due to the nature of the 4IR, in order to prepare learners for this era, there is a need for the integration of digital tools and technological platforms. These resources will enable to familiarize themselves with the digital

world.

Joo, Park & Lim (2018) emphasize the use of Technological pedagogical knowledge (TPACK) as one that plays a huge role in enhancing learner understanding. This is merely because of the experience that most learners today have on technology. Today most learners are exposed to digital tools, such as smartphones, laptops and ipads. The use of such tools in the classroom during practice definitely enhance their concentration and willingness to acquire content as resources used in class will be favorable and interesting to them. A concept may be presented in a form of a video, a picture or a digital game, to help enhance learning in the classroom, instead of strictly using text in black and white. Visuals are another form of presentation that captures attention from learners. Shabiralyani, Hasan, Hamad & Iqbal (2015) perceive visual aids as tools that enable the instructor in making learning more actual, active, motivating, encouraging, significant, and glowing by helping to clarify, establish, correlate, and co-ordinate exact conceptions, understandings, and appreciations. Learners learn and capture concepts better when they visualize that concept. Moreover, this is accomplished by the use of digital tools they may display such information.

The goal of using teaching and learning resources in the classroom, according to Amadi, Juliet & Cornelius (2022), is to help the teacher with the demonstration and data transfer of educational content and the accomplishment of educational objectives, while also assisting the students in learning and profiling various abilities and values. As a result, Amadi, Juliet & Cornelius (2022) use the following objectives as examples of what they share:

- **Student motivation**: Successful usage of pertinent resources may inspire learners. This could be achieved by fusing the particular notions with the digital resources they are most likely to encounter in their daily life. For instance, using an iPad to broadcast YouTube videos during class may encourage students to participate more and be more motivated to study.
- **Developing creativity**: The use of different digital resources may develop learner creative skills. This is due to the fact that concepts are presented differently in various platforms, and this may give learners ideas of creating their own knowledge, rather than acquiring knowledge as it is. This is what Piaget (2000) refers to as Cognitive Constructivism. People construct their own representations of the world and integrate new knowledge into their prior knowledge as they experience it and reflect on it. Same applies to exposure to

different interesting presentations of knowledge, an individual may construct their own knowledge and theories due to being introduced to such variety.

- **Evoking prior knowledge**: Good presentation of knowledge should build up from the prior knowledge an individual may have in relation to that concept. The use of relevant teaching and learning resources seek to extend prior knowledge, with the intention introducing new concepts that may be easy to understand due to the prior knowledge a person may already have.
- **Supporting the processes of comprehending, decoding, organizing, and synthesizing the educational material, as well as logical reasoning, interaction, and communication, and**
- **Assisting students in the development of various skills and the acquisition of values, as well as the retention of desirable knowledge, skills, and attitudes.**

These goals of using teaching and learning resources bring about affordances that digital tools may bring to the classroom. Dlamini & Nkambule (2020) outline three main affordances that may be brought by the use of digital devices or tools, namely; physical affordances (interaction within the physical space of the physical digital device itself and the physical environment. Such as the clicking and the typing on the digital devices, and the navigation in the physical environment such as a library.), Virtual affordances (navigation in digital platforms and having access to various presentations of knowledge), and virtually mediated social affordances (integration of social interaction with virtual platforms.). The focal point in these affordances lies in the fact that digital devices and tools seek to enhance the intake of knowledge. It enhances interactions between the physical and virtual space. Learners may interact better in group works with the help of digital platforms.

Platforms such Learning Management Systems (LMS) play a vital role presenting knowledge in a more segmented and simplified way. Bradley (2021) perceive LMS as the one that with intervening mechanisms that encourage online cooperative learning, professional training, discussions, and interaction among other LMS users, it offers an inclusive learning environment for academic success. LMSs such as Blackboard, Schoology, and so on, encourages independency. An individual may tackle the course on the own by following instructions and make sense out the information presented. This kind of a system constitutes for the skills that come with the use of digital tools, such as computational thinking.

In the framework that Kamaruzaman et al. (2019) constructed, it argues that these technological skills are vital as they serve an important purpose in the 4IR workplace. In addition to general abilities, technological skills appear to be key to people's future life happiness in today's knowledge society. Information and communication technologies (ICTs), particularly the Internet and the web, have altered every facet of human existence, from social interactions among individuals to the modernization of industries and the development of entire countries' economies. Systems in the 4IR are technology orientated, therefore it is important for learners to be made familiar of these skills so that they get prepared for the 4IR society. The Development of 4IR skills framework Kamaruzaman et al. (2019) emphasizes the importance of good relationship between educational institutions and workplaces, in accomplishing the delivery of relevant skills to the society of the 4IR. These skills serve as a bridge to surviving in the 4IR. Furthermore, these technology skills can be installed in the society successfully with the use of necessary digital tools and devices, such as online learning (LMSs) and videos for presentation of knowledge.

It is very unfortunate to discover that most teachers do not include digital tools in their pedagogies. Different factors seem to have an impact on this failure to use digital tools in teaching practice in classroom. These factors include the condition of the school environment and knowledge of digital tools. Participants interviewed made it a point that they schools lack digital resources, therefore, it makes it difficult for them to install these technological skills to learners. Thus, grade 9 Technology learners may not be equipped and not ready for the 4IR workplace.

Theme 2: Conditions of the school environment

It is evident that our schools are not prepared for the 21st century environment. This is one of the most pressing issues raised by respondents. It appears the government is doing the lip servicing when saying that our schools should use technology driven resources. The utilization of digital technologies further integrates content-required technological abilities, such as innovation, creativity, and critical thinking. These skills will successfully prepare students for the 4IR. Since the start of the fourth industrial revolution, digital technology has drastically altered and influenced the fundamental techniques of teaching and learning used around the world. The global rapid inclusion technology in education is primarily being driven by the fourth industrial revolution. The fast development of technology has improved the teaching and learning

environment in higher education in the twenty-first century particularly in the developed countries.

Despite this, South African township and rural schools face obstacles such as underdeveloped dilapidating classrooms, and insufficient utilization of technological resources. The difficulties are brought on by the skills shortage and seeming unequal terrain in the South African educational system. It is an undeniable fact that socioeconomic classes play a huge role in reconstructing and reforming the society. Anikin (2020) emphasizes on the fact that within these social classes, there will always be inequality when it comes to service delivery. Schools in a working class will most likely not be the same level as middle class. Calarco (2018) argues that middle class schools set their bar high in terms of the education system. In the middle class, education is being compensated for, therefore, the level of education delivered will be high. During data collection, the conditions of the schools were prominent. The majority of teachers believe that the current state of schools, particularly in townships and rural areas, does not promote the benefits of 4IR skills.

"Research has shown that teachers' ability to use technology to plan and implement student-centred learning activities and effective communication with parents can enhance children's learning", (Spiteri & Chang Rundgren, 2020). Most teachers interviewed pointed out that they are unable to prepare their learners for the 4IR due to lack of digital resources and the conditions of our classrooms. This can be identified that most of these teacher come from working class schools. In South Africa, most township and rural school are non-fee paying schools, and are not well equipped with digital resources. Hence, it is quiet not easy for teachers to integrate their practice with digital tools. This also deprive learners of familiarizing them with such tools, of which may required them in the 4IR workplace. In addition, contemporary learners do not have a problem in learning using digital tools, as it is part of their playing terrain.

According to Kolikant (2010) ,learners are very much able to utilize ICT tools in a form of internet processes, word processes, games, etc., and are confident integrating these tools in their studies. This automatically stimulate their interest in engaging and being active during lessons. The use of digital tools encourages learners to engage more in the lesson, rather than losing concentration. This is a matter of being more active in an activity when the intentions of an activity are clear and aligned to one's familiar ways of doing things, so as in implementing effective methods of

teaching. Learners become more active when tools such as digital gadgets are used, as it something they totally relate to and find productive. Therefore, failure of teachers to use digital pedagogies is a major impact of the production of poor results.

Today, there is an abundance of digital tools in classrooms that can help learners learn a concept more easily because these tools are aligned with their day-to-day problem-solving practice, such as the use of social media. Aside from being methods that most students are exposed to, the use of digital tools helps to develop an individual's cognition. Blumberg, Deater-Deckard, Calvert, Flynn, Green, Arnold & Brooks (2019) studied the effectiveness of digital games in developing an individual's cognitive skills, and it was evident that the use of digital gadgets and software to allows for speedy cognitive development, as preschoolers were able to grasp the skill of coding over a short span of time through digital developmentally appropriate applications (apps). Meaning, the use of digital tools in the classroom is more than just a convenience to learners as they are mostly exposed to it, but it is also an advantage to the growth of the mind. An individual grasp and processes knowledge more sufficient with the use of digital tools. For example, Sadiq, Cavus & Ibrahim (2021) believes that a 5-year-old child can be able to tackle and master addition sums digital game, of which they can find difficult to master using a pen and a paper. Therefore, digital tools play a huge role in cognitive development.

Theme 3: Knowledge of digital tools in relation to 4IR skills

The Fourth Industrial Revolution (4IR) is often compared to an approaching rainstorm, a broad pattern of change that can be seen in the distance and is moving quickly enough to leave little time for preparation. While some people are equipped with the skills to brave the shift and benefit from its impacts, others are unaware that a storm is brewing. Professionals in the education system seem to have different perspectives and knowledge on the impact that the 4IR has on the education system. Furthermore, teaching practice of the education system seem to have being integrated with limited knowledge that the 4IR intends to bring, thus lack integration of the 4IR knowledge with education to prepare the society for the 4IR. The knowledge that the teacher has on resources of teaching to be used in the classroom is vital.

Teachers appear to be unfamiliar with the use of digital tools. Teachers are still struggling to use simple tools in the classroom, such as computers and projectors. In this day and age, a teacher is

expected to understand how to use such fundamental tools for teaching and learning. Thus the respondents extensively mentioned the issue of knowledge in the use of digital tools. Education in schools has changed because of the introduction of new technology-assisted learning tools like mobile devices, smartboards, tablets, laptops, simulations, dynamic visualisations, and virtual laboratories. One of the most economical strategies for training developing minds is the Internet of Things (IoT), of which many teachers in South Africa lack knowledge of. It is also a reliable tool for including a top-notch educational opportunity for everyone.

Nilsson & Karlsson (2019) introduces a concept of 'knowledge-in-action'. This account in the knowledge that the teacher has with regards to resources, methodology and content itself.
The nature of 4IR requires the use of resources such as computers, projectors, social media, and so on. However, even though these resources are available, if a teacher does not have adequate knowledge of them, the lesson will not be delivered effectively and successfully. Some teachers interviewed raised this point of lack of knowledge of digital tools, and this factor affect their lesson delivery, even though they do believe in preparing learners for 4IR. It has been pointed out that the reason for this lack of knowledge is aligned with outdated qualifications of teaching. Some teachers were trained through outdated systems that encouraged the use of paperwork, chalkboards and textbooks, of which does not apply in nowadays. They are faced with the mammoth task to change to the new technology enhanced type of teaching. In addition, they are compelled to use these technologies of which they are not trained to use them. Nilsson & Karlsson (2019) totally are for adequate preparedness of a teacher when delivering a lesson. A teacher is required to have acquired enough knowledge of certain digital tools to use in their lesson in order to successfully prepare their learners for the 4IR terrain.

Saravanan, Julie & Robinson (2019) refers to the education system as the appropriate filed for the adoption of newly innovated systems or methods. The correct integration of content knowledge with digital tools in the classroom is vital, as it assists pupils acquire the knowledge and being able to use that specific knowledge in a 4IR workplace. Teachers' responses are evident to this as they do mention the impact lack of knowledge of digital resources has in the classroom, negatively. As most learners are already exposed to digital tools and platforms, learners through these resources would be more successful as it would help them acquire content easily.

Data Interpretation

As a result of its focus on meaning and the meaning-making process, qualitative research places interpretation at its core. According to Fossey, Harvey, McDermott & Davidson (2002), qualitative researchers make the assumption that every action has some sort of meaning and that by exploring those meanings, they can acquire a greater understanding of the pertinent social and psychological processes. Furthermore, the researcher must always interpret qualitative data because it never speaks for itself. Data interpretation has become a very significant and necessary technique, owing to some of the following considerations:

- Allows the researcher to have a thorough understanding of the abstract principle behind his own discoveries.
- The researcher comprehends his results and the reasons for their existence.
- More understanding and knowledge can be achieved by additional research.
- Provides excellent help in studies linked to research work.

Azungah (2018) argues that data can be interpreted from the perspective of 'emic' and 'etic', and further made a distinction between *phonemic* and *phonetic* explanations of language sounds. A researcher acquires the emic view, or the insider view, when they interview someone about their specific views, beliefs, and experiences because they were a part of that particular encounter. As they offer a helpful interpretation of the events, the researcher assumes the role of an outsider (etic). Other methods of data interpretation take an outsider's perspective when a researcher applies their own assumptions to the data.

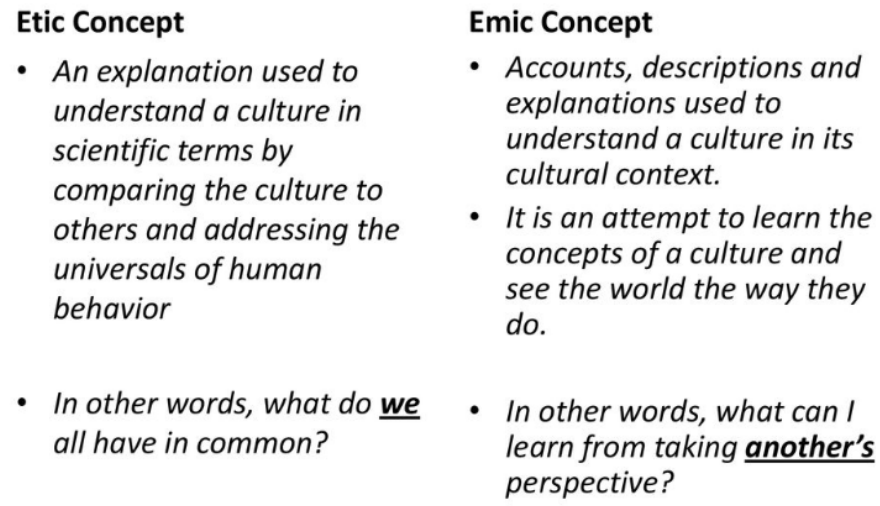


Figure 9: Presentation by Sherilyn Banks (2022)

Banks, Woznyj, Wesslen & Ross (2022) distinguish between the two concepts of etic as the one that generalizes experience into one common experience, and emic as the one that takes into consideration difference in context and experiences that individuals may come across. Therefore, this research paper interprets and views data from the emic perspective. Consideration of context is vital in this case, teachers may be situated in different environments and contexts, and therefore, come across different experiences.

4IR skills

One of the most important strategies to address the transformative impact of the Fourth Industrial Revolution, is preparedness for the future of work. In a short space of time from now, more than one-third of the skills that are believed to be essential for today's workforce will have changed according to the Future of Jobs Report from the World Economic Forum (WEF, 2018) . On-going rapid technological innovations will mean that people will be sharing workplaces with artificial intelligence platforms and bots. To stay ahead of the curve, our education system needs to commit to adapt to environmental needs that are ever changing so as to acquire and sustain relevant skills-sets required to succeed in the ever-changing workplace of the future.

The Fourth industrial revolution serves as a breakthrough in terms the socioeconomic state. Schwab (2017) emphasizes ICT as the main factor to dominate in the 4IR, and to bring the automated and technological aspect to life. Total change is expected as a result of 4IR. "The industrial revolution 4.0 (4IR) brings about a paradigm shift in the economy, social life, health, education, lifestyle, employment and skills development", (Kamaruzaman et al., 2019). This, therefore, signifies the importance of acquiring certain skills for one to be able to navigate through this era. As mentioned in the previous chapters, these skills include computational thinking, technical skills, analytical thinking and innovation, system analysis and evaluation, etc. As the most convenient form of transferring knowledge, the education system is then expected to take part in introducing and installing these skills in the society.

Leopold, Ratcheva & Zahidi (2016) argues that it is a necessity for the society to prepare for the 4IR by acquiring skills required in the 4IR as new categories of jobs will emerge, partly or wholly displacing others. Today, most industries utilize machines that not fully automated, most are operated manually, of which is a traditional routine. Because of this socio-economic transition,

digital skills to accommodate newly implemented digital equipment will be required. Success of producing a society that is ready for the 4IR in terms of skills lies in the ability of the education system to introduce and convey these skills to the society. The framework that Kamaruzaman et al. (2019) constructed mentions the relationship between the industry and educational institutions to 4IR, in relation to skills. Workplaces are mostly dependent on skills that a person may have. In this case, it lies in the hands of the education system to give training on 4IR skills that may be required in the 4IR workplace.

Grade 9 Technology teachers interviewed pointed out a number of factors that may hinder the process of introducing 4IR skills to the society. The common one being the lack of digital resources in most South African public schools. Furthermore, they emphasised that even though some South African schools do have these resources, some teachers do not have knowledge of using such resources as they were never exposed to them. It is quite a contradicting condition as it is assumed that in-service teachers are qualified to teach because they are believed to have knowledge of successfully teaching, however, if they are limited to such, it becomes an alert. Such factors may stand in the way of introducing 4IR skills to the society and may result in having a society that is not well equipped with the requirements of 4IR. This creates a gap between the bridge of being fully prepared for the 4IR and being still hocked in 3IR.

Digital technological gap

In South Africa, the digital technology gap between schools is enormous, and it varies by province. This reduces the consistency with which learners are prepared to meet the requirements of the 4IR. The 4IR is a total transformation, socially and economically, which is automated technology-based and serve to meet human needs in an efficient way. In 2017, Klaus Schwab characterized 4IR as a complete transformation of technologies, which is said to change lines between physical, biological and digital spheres. It is evident that a complete change of some technologies that we currently engage with, are yet to evolve. For instance, in this 4IR era, implementations such as of robotics are highly expected, as they are expected to elevate the economy as a whole. According to South African statistics, the highest number of imports to other countries (e.g. electrical machinery, vehicles, mineral fuels, etc.), costed approximately 9.6 US dollars in 2020. This puts a lot of concern on the image of the country's economy as South Africa is rich in minerals but lack necessary skills and knowledge to process these minerals to a useable form. It is a necessity to equip the society with manufacturing and STEM skills, so as to save South Africa's economy.

It is very important to conform and accept that as industrial and societal sectors constantly demand change, so as our education system.

> *1The Fourth Industrial Revolution represents the great tectonic shift of our time. Disruptive technologies like machine learning, artificial intelligence, and big data are changing the way we live, the way we work and do business, and the way we govern. …. Africa can and must take advantage of technological advances to industrialize, pursue inclusive growth, and attract investment. … Like the self-learning artificial intelligence we have today that was unthinkable a decade ago, we must be adaptive and responsive to the pace of change* (Cyril Ramaphosa, President of the Republic of South Africa, 2020)

According to Plante (2012), the world is becoming more technology centered, focused and driven. Indeed, this exposure to the digital world play a huge role in the use of certain approaches that may be implemented in solving any kind of problem. Approaches that will definitely make one's life easy. As mentioned in the above speech from President Ramaphosa in 2020, the South African government and the head of State are of the opinion that all South African leaners should develop coding skills and be able to create robots. In other words, all learners must be hands on digital tools that make them workplace ready on day. This pronouncement will not be fruitful as long as teachers are not preparing learners for that scale. A very close insight in industries manifest that current tools used in industrial sectors are totally advanced from those which were used 20 years ago. For instance, 50 years ago in mining industries, miners used pickaxes to drill grounds, whereas, currently, drill rigs are being used. This shows how industries evolve and constantly expecting new skills to be used to operate and run the workplace. The use of digital tools in learning Technology subject also create an opportunity for learners to diagnose problems and find solutions to them. This encourages critical thinking and problem solving.

The phenomenon of 4IR is again perceived by Oke & Fernandes (2020) as a diffusion of many technologies, and is said to blur boundaries between physical, digital and biological spheres. Although humankind is already exposed to digital technology and utilize it in many, not all areas of life, 4IR intend to transform way of life completely out of the physical sphere. A practical

[1] https://www.gov.za/speeches/president-cyril-ramaphosa-receives-recommendations-presidential-commission-4ir-6-aug-2020

instance would be online shopping platforms (such as Zando) being utilized, rather than going to a shop physically. Ong and Dino (2019, pg.4) are very much in alignment with Oke & Fernandes (2020) view of 4IR, as they believe it to be an emergence of cyber-physical systems and smart technologies which eliminate the physical sphere. Indeed, both these definitions indicate a common factor of the evolution from the physical approaches of meeting human needs to more digital and easier approaches. Therefore, the 4IR is said to simplify procedures of which industrial and societal sectors undergo to meet human needs.

Clearly, traditional methods totally limit 21st century learners from acquiring adequate amount of high-quality knowledge, as 21st century pupils are mostly exposed to the digital world, and they implement digital methods in almost all angles of their lives. Teaching 21st century pupils utilizing hardcopy textbooks and writing a whole lot of notes on the board will not do any justice to the young ones, instead, it deprives them from getting access to high-quality education (supportive, developing and enhancing education) that will play a huge role in preparing them for the society. Now, the question stands, are teachers equipped enough to teach using digital tools? Or rather, are digital tools themselves available in schools?

The availability of digital resources in most South African public schools seem to be an issue. Most teachers interviewed indicate the challenge of having limited digital resources or no digital resources at all. It is quite known that the education system is a channel in which the society is being able to be reformed, with the intention of introducing newly invented systems. The lack of resources could deprive the education system from successfully deliver these newly invented systems. The gap lies in the midst of the availability of digital resources, knowledge of digital resources and integration of digital resources with content knowledge. This gap plays a huge role in depriving learners from moving from a point of traditional learning perspective to a modern and digital perspective. This hinders them from acquiring skills and knowledge of technology to get prepared for the 4IR.



Traditional Classroom Setting[2]



Modern Classroom Setting [3]

It is important to look at the gap that lies pre and post 4IR in the classroom setting as it one of the underlying factors to successfully delivering skills and knowledge to the society. As Idris, Hassan, Ya'acob, Gill & Awal (2012) argues, education shapes the society. It is through education that the society gains consciousness on certain things and follow a certain procedure when doing things. This simply means that for an individual to perceive themselves as who are, it is through education, especially formal education that consists of formal settings and follow a certain procedure of transferring knowledge.

The above two pictures represent classroom settings in two different ways; traditional and modern classroom settings. It is obviously identifiable that these two settings differ, and as a result, present knowledge in different ways. Technology teachers should be considered as change agents in the 4IR; hence, their attitudes toward technology may be either developmental or detrimental in terms of furthering learners' advancement in the 21st century. Teachers' roles are not just to educate, but also to offer an education that leaves no learner behind. Table 3 shows the modern classroom setup that promotes the requirements needed in the 4IR.

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2 https://www.google.com/search?q=CHALKBOARD+AND+CHALK+african+CLASSROOM&tbm=isch&ved=2ahUKEwiXuK_-2oX7AhVS0YUKHSesAQYQ2-cCegQIABAA&oq=CHALKBOARD+AND+CHALK+african+CLASSROOM&gs_lcp=CgNpbWcQAzoECCMQJ1DLB1iXFmDHIGgAcAB4AIABwwKIAcQRkgEFMi03LjKYAQCgAQGqAQtnd3Mtd2l6LWItZ8ABAQ&sclient=img&ei=6kBdY5ebJdKilwSn2IYw&bih=757&biw=1440&rlz=1C1GCEU_enZA1029

3 https://www.google.com/search?q=ict+modern+classroom&tbm=isch&ved=2ahUKEwjVi_3yzoX7AhU4uScCHc7fCsEQ2-cCegQIABAA&oq=ict+modern+classroom&gs_lcp=CgNpbWcQAzoGCAAQBxAeOggIABAIEAcQHlAAWMYFYPEHaABwAHgAgAH1AYgB-QaSAQMyLTSYAQCgAQGqAQtnd3Mtd2l6LWItZ8ABAQ&sclient=img&ei=PTRdY5X5HbjynsEPzr-riAw&bih=757&biw=1440&rlz=1C1GCEU_enZA1029#imgrc=DGWUu5tS5aTnKM&imgdii=IQy2ohZXpZwlZM

Table 3: Differences and Similarities between traditional and modern classroom settings

Differences between traditional and modern classroom settings			Similarities between traditional and modern classroom settings
	Traditional setting	Modern setting	
Teaching and learning method	Teacher centred. Learners acquire knowledge provided by the teacher and make use of it.	Learner centred. Learners interact and engage during the lesson, and construct their own knowledge.	The facilitator (teacher) is the one that give instruction and leads learners in the lesson.
Resources	Uses the board to present concept.	Uses digital devices to present concepts, and learners are exposed to different digital platforms that present concepts in different ways.	The teacher introduces knowledge. Learners do not decide on their own on what they what to learn.
Sitting setting	Learners are lined up in rows, which makes it difficult for them to interact and discuss.	Learners are put in small groups to make it easy for them to interact and share knowledge with each other.	
Type of education	Subject specific knowledge	Subject and skills based knowledge	

The traditional classroom has drawn harsh criticism for being outdated, teacher-centered, restrictive, and lacking in creativity, (Al-Hadithy, 2015). Instead of actively participating in the learning process, the learner passively assimilates the information imparted. The traditional classroom setting lacks the integration of profound resources such as digital resources. The fact that learners are limited to acquiring knowledge provided to them, rather than exploring different kinds of knowledge presentation, deprive learners of their ability to construct and make use of knowledge effectively. This concept is in line with Scrivener (2012) metaphor, according to which "conventional teaching [is supposed to work as] 'jug and mug,' with knowledge being poured into an empty one." Learners are simply “spoon-fed” knowledge by the teacher. They do not intend to explore other ways of learning, discuss with peers and later construct their own knowledge. In this case, learners will not be able to acquire skills necessary for the 4IR, such as critical thinking, computational thinking, digital skills, and so on, as they are not exposed to resources that may introduce them to such skills.

On the other hand, a modern classroom setting consists of complete different factors. Gupta & Pathania (2021) characterize a modern classroom as the one that consists of digital technology resources that serve a purpose of instilling digital skills on learners. However, digital resources are one of many components that may be found in a modern classroom. The sitting setting of learners says a lot about the methods of teaching and learning that may be applied, as well as knowledge to be presented. Learners sitting in groups form constructive discussions and have a potential in constructing their own knowledge. Modern technique is significantly more focused on the needs of the learner than old methodology. Scrivener (2012) asserts that the primary responsibility of the instructor is to make learning happen, which entails engaging the students in the process by allowing them to work at their own pace, by not delivering long explanations, by encouraging them to participate, chat, interact, do things, etc.

Modern methodology aims for something different; hence, the means by which the goal is accomplished have also changed. To meet the learners' new needs—in this example, 4IR skills—teachers has to modify their teaching strategies, curricula, and resources. The usage of digital technologies in this setting promotes learning and aids students in developing necessary abilities. However, it does not stop there; teachers must also possess sufficient expertise of these digital resources, including digital projectors, LMS, and other tools. If a teacher is given the tools they need but is unable to use them, it makes no sense, let alone no progress. One of the contributing aspects mentioned by the participants is that some of the students are located in schools with ample resources but are unable to make use of those facilities. Unquestionably, the fact that the educational system occasionally changes is advantageous. This happens as a result of social and industrial development. A teacher who has been working in education for more than 20 years is likely to know little to nothing about digital resources because they may have received their training before the integration of digital technologies. This then affect their application of teaching methods in the classroom.

It is clear that there is a difference between old teaching methods and modern methods of instruction that are intended to prepare students for the 4IR. The process of achieving the objective of preparing students for the 4IR is greatly hampered by this gap.

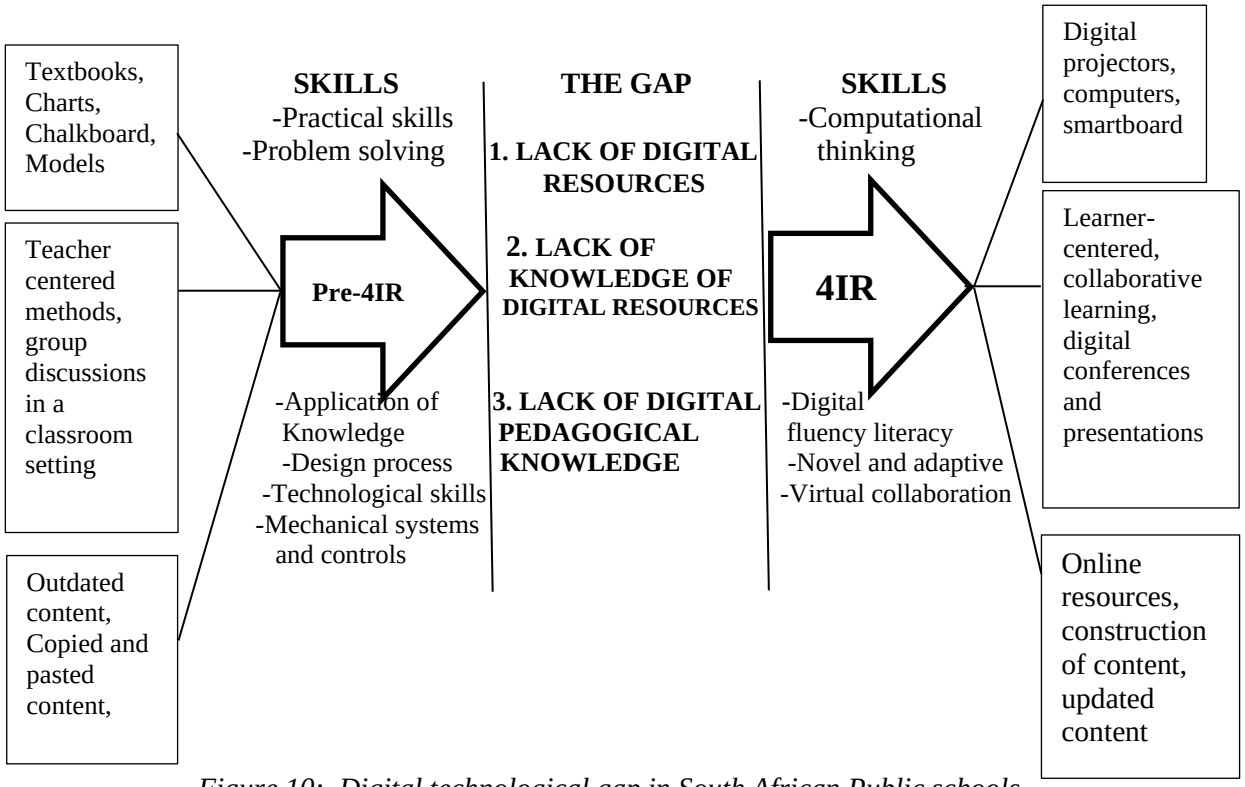


Figure 10:. Digital technological gap in South African Public schools

It has been mentioned in this chapter that most teachers interviewed emphasize on the issue of lack of digital resources as the main issue that deprives them from delivering content successfully, and from preparing learners for the 4IR. This creates a gap from the 'unknown' to the 'known'. Another factor that creates a gap is the lack of knowledge that most teachers have on digital resources. Let alone the capability of integrating these digital tools with content knowledge. The framework above shows the effect that these factors have on education to deprive Grade 9 Technology teachers from preparing learners for the 4IR. Table 4 breaks down components of the gap.

Table 4: Components of the gap, Pre- and Post 4IR skills

Components causing "The Gap"		Pre- and Post 4IR skills
Lack of Digital resources	• The use of textbooks, Charts, Chalkboard, Models instead of using digital resources such as digital projectors, computers, smartboard. • Limit learners to textual resources rather than various, interesting, digital resources that may help them develop 4IR skills. • Exposure to provided knowledge. Learners are unable to use different references to differently present knowledge.	Due to the gap, learners are equipped with the following skills: • Practical skills • Problem solving • Application of Knowledge • Design Process • Technological skills • Mechanical systems and controls, • rather than 4IR skills: • Computational thinking • Digital fluency literacy • Novel and adaptive • Virtual collaboration • Analytical thinking • Reasoning, problem solving and ideation
Lack of Knowledge of Digital resources	• Limit teachers from presenting concepts in clearer and eye pealing methods. • Outdated content copied and pasted content is presented. Online resources for the accumulation of updated content knowledge are not included. • Limit teachers from instilling 4IR to learners and from preparing learners for the 4IR workplace.	
Lack of Digital Pedagogical knowledge	• Inability to use relevant digital resources in integration to content knowledge. • Teacher centred methods are used; group discussions in a classroom setting are avoided. • Deprive learners of necessary skills.	

The existence of these three primary factors that create gaps in educational systems slows the pace

of social development in general. One of the main forces behind the fourth industrial revolution is technology. Cloud technology, the internet of things (the creation of intelligent devices), the network of services (smart logistics and smart mobility), and the internet of energy (the effective use of environmental assets) are just a few of the technologies that have taken on a significant role. As a result, a disparity in educational institutions' knowledge of and access to digital technology serves to prevent society from achieving its 4IR acquisition target. This lack of educational institutions is in opposition to the society's potential traditional skills since it does not meet the demands of the 4IR workplace.

Preparing learners for the 4IR terrain

During the authority of the missionaries, education provided to the society were entirely based on the knowledge of labor and industries, and further colonize Africans. Meier zu Selhausen (2019) argues that Mission societies use the platform of the education system to convert Africans to Christians, through the teachings of Christianity that were believed to be 'true' and the only knowledge that could help one navigate in the society. This evidently shows the impact of the education system in the society. Education is capable of changing perspectives and shape minds. It is capable of equipping and transmit skills and knowledge that could be useful in the society.

Most grade 9 Technology teachers interviewed believe in pedagogy and teaching resources as the most effective factors that could help a lesson to become a success. They believe in the use of digital resources and ICT to successfully and assist in preparing learners for the 4IR terrain. This is simply because the 4IR is believed to be centered around technology, therefore, familiarizing learners with such resources could help prepare them for the 4IR space. It becomes much of a challenge in most South African public schools as they are hardly resourced and could be impossible for them to use such resources. Well, the question would be: "To what extent does a teacher prepare their learners for the 4IR during their standard lesson?" Due to the nature of education, whereby, in order to fulfill the objectives of the lesson, a teacher should integrate concepts with relevant resources. In order to prepare learners for the 4IR, teachers are encouraged to make use of digital resources and learner-centered methods.

As per Osborne & Dillon (2008), critical and analytical thinking pedagogies should be applied in the teaching of the technology subject because teaching is not just about understanding the subject

at hand but also knowing how to apply it. The exposure to effective digital devices and learner-centered methods will allow learners to critically think with the intention of solving a problem at hand. Teachers must have strong decision-making skills in order to help students learn to see challenges as opportunities. With this way of thinking, students will be able to work with various disciplines while exhibiting sincerity, empathy, and unconditional positivity.

According to Agumba, H. & Akala, B (2019), to eliminate the borders that separate disciplines, interdisciplinarity is achieved by combining various concepts and making use of the links between various topics. Interdisciplinary pertains to more than one field of knowledge. It demands that the curriculum and pedagogy be refocused in order to provide possibilities for building social spaces. This is what Pratt (1991) calls “contact zone”, where different cultures interact, conflict, and wrestle with one another, frequently in settings with extremely uneven power relations. Within this space, learners are exposed to different sources, presentations, views and opinions. As a result, learners are placed in an environment that allows them to foster thinking and learning beyond the intellectual, physiological, emotional, social, and religious borders of their daily existence. Yoo (2017) underlined the need for people to develop their problem-solving, ethical decision-making, and vocational abilities. Thus, the education system needs to align its curriculum and methods of teaching with these skills, as they dominantly in demand in the 4IR. A learning environment that can develop managers who can operate future smart industries, employees who can use modern devices, and talents who can access diverse culture is necessary for the Fourth Industrial Revolution's new paradigm.

With regards to the responses from participants interviewed. It can be drawn that most public schools in South Africa are not well equipped and ready for the 4IR. Classes are not well resources, as they lack resources such as digital technologies, and methods of teaching that teachers use are limited, as they are not inclusive. According to Winterton & Turner (2019), "job preparation after graduation" is a concept that calls for collaboration between universities, governments, and the business sector to ensure that college graduates are prepared for the business sector. How then are learners being prepared for the 4IR workplace if they being deprived the opportunity to grasp and acquire skills that may be needed? Examining the relationship between graduates and the labor market can help the educational system create the talent that is required in real life.

Education will need to support learners in developing the attitude and skill set to do anything in

the future rather than just "something" specific as we move further into the future. Regardless of household wealth, age, or gender, STEM (science, technology, engineering, and math) education needs to be improved on a universal basis. There is no question that every worker in the future will require certain technological abilities, and STEM education needs to be improved, but it is crucial to remember that we should not take an either/or attitude. According to Razi & Zhou (2022), the goal of this educational project was to provide all learners the critical thinking abilities that would enable them to solve problems creatively and, in turn, make them more marketable to employers. Razi & Zhou (2022) explains the four strands of STEM as follows:

- **Science** is the methodical investigation of the makeup and behavior of the physical and material cosmos, based on measurement, experimentation, and the formation of generalizing rules (Science, 2012).
- **Technology** is the field of knowledge that examines the development and application of technological tools, as well as how these factors interact with human life, society, and the environment. It draws on a variety of disciplines, including engineering, applied science, and pure science (Technology, 2012).
- **Engineering** is the art or science of applying information from the pure sciences, such as physics or chemistry, in practical ways, such as when creating engines, structures, buildings, mining, ships, and chemical industries (Engineering, 2012).
- Using specialized notation, **mathematics** is a group of linked sciences that includes algebra, geometry, and calculus and is concerned with the study of number, amount, shape, and space as well as the links between them (Mathematics, 2012).

It is an undeniable fact that this kind of education can be obtained successfully with the use of pertinent and necessary resources, in this case, digital technological resources. It should also be conducted using methods that could allow for interaction among students and the exploration of various points of view on concepts. In the 4IR, cognitive skills are crucial, but they can be successfully and effectively acquired with the aid of digital technological resources since they enable the examination of a variety of sources.

Conclusion

Although 4IR offers a lot of opportunity, one of the main concerns is how organizations and deeply ingrained educational systems will be able to adapt to these changes and disruptions. In

order to negotiate meaning across disciplines, where its rewards and problems lie, communication is essential. The effects of this strategy on classroom instruction and teachers' professional growth necessitate the establishment of teacher education programs that encourage collaborative learning and inquiry-based learning that is focused on cross-disciplinary activities. In South Africa, there is still a long way to go, considering the fact that most public schools in the townships seem not be aware and ready for this 4IR terrain.

Chapter 5: Discussion, Recommendations and Conclusion

Adequate levels of education, as well as digital skills competency and capability, are critical in ensuring that South African technology teachers realize the benefits of the 4IR. However, this is a significant challenge that South Africa has in meeting the educational demands of its rising population of young generation. The difficulty is exacerbated by the unequal terrain of social structure which often limits their access to decent education (Dewa, 2022). Technology, notably always-on, dependable connection, offers an appealing alternative. The study is concluded in this chapter. The conclusions drawn from this study's findings of the interviews of grade 9 Technology teachers regarding the extent to which Technology grade 9 learners are being prepared for the 4IR are described. Research recommendations are provided, and the study's findings are discussed.

5.1. Discussion

The research is discussed in a section where the authors go further into the significance and applicability of the findings. It is concentrated on outlining and assessing what was discovered, demonstrating how it links to the literature review and research question, and putting up a case in favor of the overall result. The purpose of discussion is to:

- explain any new knowledge or fresh insight regarding the research subject being explored as well as to evaluate and
- describe the importance of the findings in light of prior knowledge.

With consideration to the main intention of the study, which is to answer to the main question: How do Grade 9 technology teachers prepare learners for the 4IR in their teaching practice? , grade 9 Technology teachers made it a point that there is limited knowledge and awareness of the 4IR, thus making it difficult for them as teachers to equip their learners with necessary skills. The result indicate that learners are currently not being prepared, and teachers are unable to provide effective methods and pedagogies due to lack of resources, TPK and the knowledge of 4IR itself. Procedures and habits in the majority of human work fields have undergone a significant change with the emergence of digital technology. According to Dlamini & Mbatha (2018), content delivery varies in the way that teacher learning is structured, how long it lasts, how quickly it proceeds, the resources and tools chosen to involve instructors in the learning process, the location of the learning, and the criteria used to choose the participants. Proponents of education technology frequently predict similar radical changes to how teaching and learning are done. However, it is now obvious that the vision and reality in education are very different.

Responses to the findings

The study addresses the findings in the following manner:

1. What methods of teaching do technology teachers practice, that prepare learners for the 4IR?

Due to bad conditions in most public schools, whereby there is less infrastructure and lack of digital resources, grade 9 Technology teachers indicated that methods that they use in their classrooms during lessons are mostly manual and outdated. This indicates that they continue to employ the old-fashioned techniques of using chalkboards and textual materials like books and charts. As a result, it is almost impossible to prepare learners for the 4IR as resources to do so are unavailable. Furthermore, participants indicated that they use a teacher-centered teaching approach, as it strictly limits leaners to the content knowledge provided by teachers. Reason being is that this approach of teaching avoids confusion of learners when it comes to acquiring content knowledge. If learners could obtain exactly what is being taught by the teacher, recall the knowledge successfully, and move to the next grade, then that would be the kind of education the opt for due to the kind of resources they have. Basically, learners are being spoon-fed knowledge and are required to recall the same knowledge, and according to the participants, that is regarded as learning.

2. What are the 4IR skills that technology teachers should impart to learners?

Participants stressed digital technology abilities as a significant skill due to the nature of the 4IR. This is because during this era, the industries will be fully automated. Machines that are manually operated today will be automated. Some participants included the fact that although digitals will be dominant in the 4IR, cognitive skills such as problem solving, critical thinking, innovative skills are also important. Therefore, as teachers, it is necessary to teach with the goal of imparting these skills to learners.

3. What digital technological gap (knowledge and skills) do technology teachers have when using digital tools that may prepare learners to meet the needs of the 4IR?

It is a great unfortunate that teachers and the education system experience a gap that deprive them of the introducing skills and knowledge of the 4IR to learners. A digital technological gap that was indicated by participants lies in the fact that as teachers who have been in the teaching field

for fifteen to twenty years, it is quite a challenge for them to operate and integrate content knowledge with digital resources. Reason being is that, during their teaching training, of which took place mostly in the 2nd industrial revolution, where digital technologies were not yet introduced, therefore, they are not equipped with digital technological skills of operating these resources. This is one of the factors that cause a digital technological gap to meet the needs of the 4IR.

Most participants indicated the issue of lack of digital resources in schools. The absence of these resources in schools deprive them an opportunity to make use of them in classroom in order to impart necessary skills of the 4IR.

4. How do technology teachers envision ideal ways of preparing learners for the 4IR terrain?

According to participants, ideal ways of preparing learners for the 4IR are aligned with the introduction of digital resources to learners and encourage them to create their own knowledge on concepts, as a result, that will also enhance their cognitive skills. In a normal well-resourced classroom, a teacher may encourage learners to form discussions on concepts, develop their own theories, make use of digital platforms to explore different presentations of concepts and independently learn and solve problems. This will obviously be accomplished with the facilitation of the teacher, who will guide learners in terms of content knowledge and making use of it, throughout the lesson. It is evident that the ability to comprehend what is essential today for tomorrow is the fundamental issue for any learning theory, and that learning how to learn is more important than absorption of knowledge. Any learning theory, especially a novel one like connectivism, should strive to teach students how to learn and apply what they have learned in practical ways while maintaining a positive attitude (Herlo, 2017).

Answering the main question:

How do Grade 9 technology teachers prepare learners for the 4IR in their teaching practice?

In most public schools situated in townships learners are not prepared with necessary skills and knowledge for the 4IR. A few factors were pointed out during the interviews.

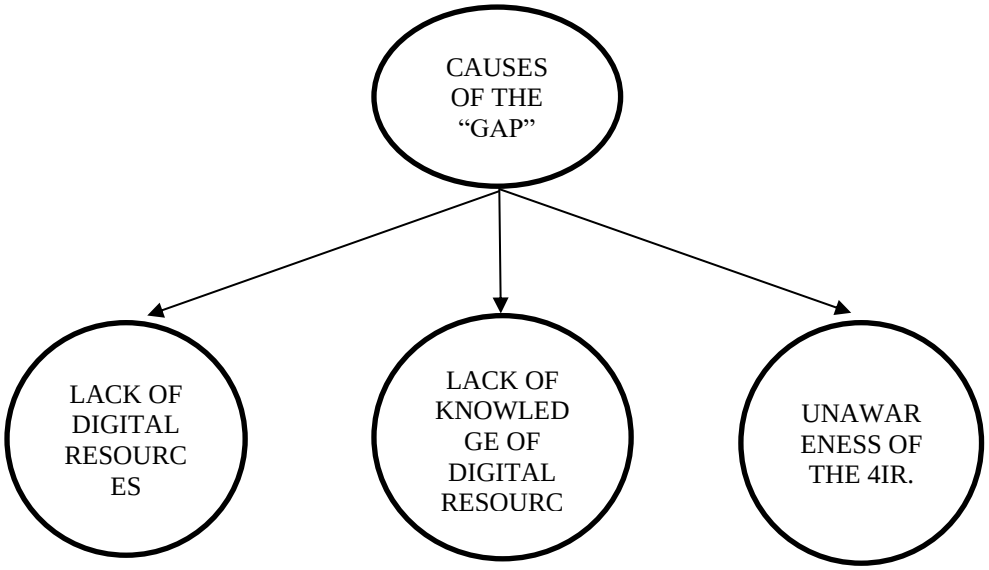


Figure 11: Causes of the gap

- **Lack of digital resources**

Due to lack of digital resources in most public schools, teachers are unable to introduced and impart skills and knowledge of the 4IR to learners. Teachers still use traditional methods of teaching which limit learners to only the same kind of content knowledge and skills, which will not develop their thinking and ways of doing things in any way

- **Lack of knowledge of digital resources**

Due to lack of knowledge of digital resources, teachers are unable to integrate the content knowledge with digital resources. This is even in the case of the presence of digital resources in their schools. Failure to operate these resources will deprive them of using them in their teaching. This is because for an effective lesson to be conducted, relevant resources, in this case "digital", are to be used.

- **Unawareness of the 4IR**

Some participants seem to perceive 4IR as impossible. Reason being is that the economic conditions of the country are still developing. Most sections of the country are still left behind in terms of technologies. For instance, some parts of the country do not have electricity, some do not have clean running water. How then is the country expected to experience the 4IR if they are still unable to fulfill basic needs of the society? These participants still stick with the old-fashioned ways of teaching, as they do not foresee any great change in the society.

Therefore, it has be drawn from the responses of the participants that some of South African public schools do not, or are slightly preparing learners for the 4IR, due to lack of digital resources in schools, lack of knowledge of digital resources and unawareness of the 4IR.

5.2. Limitations of the study

The conditions under which the data were gathered and the number of public schools where the study was permitted to participate are what are considered the study's limitations. Due to COVID-19 that led to the country shutting down, deprived the researcher to physically collect data in terms of interviews. In this case, the researcher was limited to the interview aspect of collecting data, without having observe the contexts of participants. Although interview questions included description of the participants' context, the presence of the researcher in schools was going to have a great input in the findings of the study. Furthermore, the Department of Education only permitted the study to take place in ten public schools. This limited the study as findings were only limited to those schools. Though the study was entirely objective in terms of findings, however, the inclusion of public schools in different townships would benefit the findings of the study.

5.3. Recommendations

The aim of this study was to determine the extent to which grade 9 Technology teachers prepared their learners for the 4IR. This study focuses on South African public schools, situated mostly in townships. It has been drawn, from the responses of the participants, that some public school in South Africa are not well resources and equipped with 4IR knowledge, therefore, they are unable to prepare their learners for the 4IR. Due to the factors that hinder progress of preparing learners, it is obvious that these factors can be avoided, or rather looked into, so that a solution may be found.

A few recommendations can be made, with the intention of bringing solutions to this problem. These recommendations based on the finding of the study are as follow:

- The response to the adjustments that the 4IR will make in relation to digital technology and the improvements being achieved must heavily involve the educational system. They need to support innovative technologies that raise educational quality while looking beyond the sociocultural capital of the ecosystem in which schools are located (Tucker, 1996). No matter how much sociocultural capital a student possesses, they should take use of the options available to them and prepare them for participation in the 4IR space by

teaching them digital technology skills that will safeguard their future citizenship.

The department of education should create a space that recognizes the importance of the integration of digital technological resources for teaching and learning. This can be done by providing these resources, such as digital projectors, smartboards, tablets, and so on, in schools, to make the accessible for learners. In this way, learners will be familiarized to these digital resources and therefore be able to acquire digital and cognitive skills of the 4IR. Teachers may also make use of these digital resources in their teaching, of which will enhance content knowledge delivery.

- By incorporating, supporting, and highlighting the use of these resources in teaching, the policy makers should consider how to accommodate the integration of digital technical resources with teaching and learning. The fact that most participants indicated lack of integration of digital resources during lessons clearly indicates that there is not emphasis of the use of these resources in the policy itself. This is because teachers teach according to the policy, of which in this case, this policy favors traditional ways of teaching and learning, the most.
- Short courses can be introduced to teachers will less or not skills of using digital resources. These short courses can preferably be provided to teachers who have been in the field for the longest time, because it is assumed that in their teaching training, these digital resources were never exposed to them.

5.4. Conclusion

When conducting qualitative research, study conclusions are arbitrary. The researcher may draw findings after carefully examining respondents' attitudes, the causes of their replies, and their psychological motivations. In the attempt of investigating content knowledge and pedagogy that teachers use to prepare learners for the 4IR, it is clear that the needs of grade 9 technology students are not being sufficiently met by the current educational system, which accounts for the sluggish or nonexistent adoption of the skills needed in the 4IR domain. Evidence from the literature suggests that a number of variables may affect how successfully learners are taught the 4IR-related abilities. These elements might be the materials used in the class, the methodology utilized in connection to the subject knowledge and the digital resources themselves, the instructors' expertise of digital technology resources, and their familiarity with 4IR. Participants made it a point that they are unable to thoroughly prepare learners for the 4IR due to lack of these elements. As Kamaruzaman, et al. (2019) have stated in their development of 4IR skills framework that, the

relationship and communication between the educational institution and the demand of the current workplace places a vital role in imparting necessary skills to the society. This gives the society an advantage to partake in the workplaces and be able to sustain life.

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Appendix A

WITS SCHOOL OF EDUCATION

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Ngcobo

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H21/09/33**
PROJECT TITLE	Preparing Grade 9 Technology Learners for the Terrain of the Fourth Industrial Revolution
INVESTIGATOR(S)	Ms Z Ngcobo
SCHOOL/DEPARTMENT	Wits school of Education/
DATE CONSIDERED	17 September 2021
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	10 November 2024

DATE 11 November 2021 **CHAIRPERSON** _____
(Professor J Knight)

cc: Supervisor : Dr A Dewa

Appendix B

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**14 October 2021**
Validity of Research Approval:	**08 February 2022– 30 September 2022** **2021/255A**
Name of Researcher:	**Ngcobo ZS**
Address of Researcher:	**27 Browning street**
	Jeppestown
Telephone Number:	**0614425324**
Email address:	**1533396@students.wits.ac.za**
Research Topic:	**Preparing Grade 9 Technology Learners for the Terrain of the Fourth Industrial Revolution.**
Type of qualification	**M.Ed.**
Number and type of schools:	**7 Secondary Schools**
District/s/HO	**Johannesburg East**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

15/10/2021

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

3. ***Because of COVID 19 pandemic researchers can ONLY collect data online, telephonically or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate. The approval letter will then indicate the type of arrangements that have been made with the school.***
4. ***The Researchers are advised to make arrangements with the schools via Fax, email or telephonically with the Principal.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School*

7. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Mrs Faith Tshabalala
Acting Director: Education Research and Knowledge Management

DATE: 15/10/2021