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INVESTIGATING TEACHERS' PERCEPTIONS ON UNEMPLOYMENT CAUSED BY THE POSSIBILITY OF DEPLOYING ROBOTS INTO THE TEACHING PROFESSION: A CASE OF THREE SCHOOLS IN SOUTH AFRICA

Masters Research Report

By

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A research report submitted in partial fulfilment of the requirements for the Degree of Master of Education in the Faculty of Humanities, Educational Leadership and Policy Studies at the University of the Witwatersrand.

Johannesburg, 2023

DECLARATION

I, Maida Sitoe (Student number: 1628079) a student registered for a Master's Degree in Education, specialising in Educational Leadership and Policy Studies at the University of the Witwatersrand declare that the research report submitted for the Master of Education degree was entirely written by me and it has not been submitted before for any other degree, assessment or examination to this or any other university.

Signed:



_____ ___12th day of March 2024__

MAIDA SITOE DATE

ACKNOWLEDGEMENT

Thanks to Jehovah for giving me the strength and the ability to complete this research report. It has been a difficult journey, yet Jehovah himself constantly gave me the knowledge and the wisdom I needed to see this research project through till the end.

I am grateful to Dr More Chakane, my supervisor for the continuous encouragement and support to strive for academic success. It was indeed an honour to work alongside Dr Chakane as one of the prominent South African leaders in the field of education. As I embark on this journey of academia, I intend to make contributions that will better the South African education system as I was inspired by the lifelong contributions made by Dr More Chakane in Sci-Bono, South African schools and educational policies.

I am grateful to the Whitmore Richards bursary and the Gauteng Department of Education for funding my master's project.

DEDICATIONS

I dedicate this research report to my brother John Sitoe and my parents Martha and Carlos Sitoe, for their support throughout my study period from undergraduate until now. May Jehovah keep us in unity and support each other's dreams as we wait for the promised day.

To my academic friend Sara Seopetsoa, thank you for the support, sacrifices and positive energy that motivated us to strive for greatness. I am honoured to have learnt a lot from you. Until the day we both become Doctors (PhD), I shall continue to support your dreams.

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ABSTRACT

The influence of globalization is inevitable and the quest to remain globally relevant has created a growing demand for integrating technology into different facets of life in response to the Fourth Industrial Revolution (4IR). The challenge of introducing technology into various sectors of the economy shifts away from the demand for low-medium skilled candidates to a need for highly skilled candidates which in turn would lead to automation and mass unemployment.

Teaching is considered one of the most secure jobs in the world. However, the introduction of social robots in classrooms to serve as teachers or assistants may be seen as a threat to teacher employment. One of the repercussions of introducing Robot teachers into classrooms despite raising concerns regarding practicality and learner's safety, further intensifies teacher insecurities regarding the teaching profession.

Despite the substantial amount of literature addressing the concept of robots about teaching and how teachers perceive the concept of robots replacing their role; most existing literature focuses on how deploying robots can enhance teaching and learning. It addresses the practicality of deploying robots and raises awareness of ethical concerns regarding learner's safety. Thus, to the researcher's knowledge, there are hardly a limited number of studies that address how teachers feel about the concept of robot teachers replacing them in a South African context. As a result, this study aimed to investigate the different teacher perceptions on the possibility of deploying robots in South Africa.

The study was quantitative and utilized a positivist approach. Data was collected from three different South African schools classified as Quintile 1, Quintile 4, and Quintile 5, through a closed-ended survey questionnaire and interviews. The sample consisted of 45 secondary school teachers serving as post levels 1 and for further analysis only 4 teachers were selected for a face-to-face interview. Findings show that most teachers do not fear the notion of being replaced by robots. Due to limitations such as Economic constraints, poor infrastructure lack of resources, inequalities and lack of access, 73% of the teachers believe that integrating robot teachers in a

South African context is impractical. Surprisingly, 80% of teachers feel and believe that robots should *only* be employed to assist teachers in performing daily tasks in a classroom.

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LIST OF TERMINOLOGIES

Terminology	Meaning
Automation	The use of technology to perform a repetitive task with minimum human interaction (Goldberg, 2012).
Technological Unemployment	When humans lose their jobs due to the development of technology (Acemoglu & Restrepo, 2020).
Robot	A constructively designed machine used to facilitate and perform tasks done by humans (Sims, 1987).
Humanoid robot	A machine with characteristics and physical features that resemble a human being and interacts with humans (Malinowska, 2021).
Automatability	The possibility for jobs to be automated (Frey and Osborne, 2017).
Globalisation	The interconnectedness of countries around the globe through technology, through an extensive network of economic, cultural, social and political spheres (Yalcin, 2018).
Teacher Perception	The way individuals [teachers] view and understand the world (McDonald, 2011).
Quintile 1	Quintile 1 schools in South Africa are classified as schools that cater to the poorest 20% of learners in the province and non-fee-paying schools (SASA,1996).
Quintile 4	Quintile 4 schools in South Africa cater to the least poor 40% of learners and a fee-paying school (SASA,1996).

Quintile 5	Quintile 5 schools in South Africa cater to the least poor 20% of learners and are classified as fee-paying schools.
Post Level One	First entry-level teachers in South African public schools (PAM,1999).
Post Level Two	Teachers appointed as "Departmental heads" (PAM, 1999, p. 302)
Post level Three	Teachers appointed as "Deputy principals" (PAM, 1999, p. 302)
Post Level Four	Teachers appointed as "school Principals" (PAM, 1999, p. 302)

LIST OF ACRONYMS AND ABBREVIATIONS

4IR/ 4.0	Fourth Industrial Revolution
AI	Artificial Intelligence
DBE	Department of Basic Education
DoE	Department of Education
OECD	Organisation for Economic Cooperation and Development
SONA	State of the Nation Address
EV	Eigenvalue
PL1	Post Level One
PL2	Post Level Two
PL3	Post Level Three
PL4	Post Level Four

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The Fourth Industrial Revolution (4IR) is advocated to have the capacity to uplift social injustices in South Africa (Olaitan, Issah & Wayi, 2021). In the State of the Nation Address (SONA, 2018), the South African President, Cyril Ramaphosa proclaimed the incorporation of the 4IR into the economic policy, with the objective that the digital industrial revolution committee would help his government take advantage of the rapid technological advancements (Sutherland, 2020). Moreover, policies such as the White Paper on Science, Technology, and Innovations (2019) have been framed to ensure that policy on educational change aligns with the 4IR in South Africa (South Africa Republic, 2019). This portrays the influence of globalization and the quest to remain globally relevant. However, for the unemployed youth, these policy frameworks are meaningless since the integration of technology in the form of 4IR and globalisation does not necessarily translate into job creation nor does it eradicate poverty for them. Similarly, this initiative seems to be a threat for some teachers in terms of job security on the basis that Mbokazi, Lebeloane and Mkhasibe (2023) opined that the educator's unemployment rate rises alongside the overall unemployment rate in South Africa.

In South Africa, an estimated number of 20,000 teachers were reportedly unemployed in 2021, of which half of them had been previously employed as teachers (Shepherd, 2020c). According to Bennell (2023); Mapepa and Adekoye (2019); and, Mbokazi et al. (2023), teacher unemployment is a great concern for many Sub-Saharan (developing) countries and it is influenced by factors such as economic constraints, oversupply of qualified teachers, military conflict, migration and more. Within the context of South Africa, a teacher (also known as an educator), refers to someone who adheres to the Employment of Educators Act 76, section 1 (1998), which explicitly states that an educator is someone who teaches, educates or trains other people by providing them with educational services.

The phrase '*someone who teaches, educates or trains*' in the description above does not make provision for a robot, since robots are identified as objects or things. However, recent research (Brink & Wellman, 2020; Sharkey, 2016; Ewijk, Smakman, & Konijn, 2020) has identified that in

countries like Japan, Singapore, France and more, social robots are becoming increasingly prevalent in classrooms to serve as teachers or assistant teachers. Relevant to this study, when a robot serves as a teacher, children are not building or programming the robot but rather encountering an apparent social being offering them teaching services (Sharkey, 2016).

From several studies, it is evident that most developing countries are grappling with teacher unemployment challenges (Bennell, 2023; Mapepa & Abimbola Adekoye, 2019; Mbokazi et al., 2023). Therefore, the notion of deploying social robots into classrooms does not only add to the fear of pre-existing unemployment rates and concerns for practicality, but it may further intensify teachers concerns regarding implementation, availability of resources and anxiousness about the teaching profession among sub-Saharan teachers. Hence, in establishing the aforementioned challenges, this study sought to explore and uncover teacher's perceptions of technological advancement and fear of teacher unemployment in a South African context.

The concept of integrating robots into the workplace is not new, rather it emerged around the 1960s were robot machines released humans from performing risky and harmful activities in factories (Garcia, Jimenez, De-Santos & Armada, 2007). The integration of robots in workplaces not only improved safety by elevating humans from dangerous tasks but also improved quality and increased production time in contrast to manual labour. However, these technological advancements resulted in human unemployment, especially in certain positions where people were made redundant by robots (Acemoglu & Restrepo, 2020).

The economist Maynard Keynes coined the term Technological unemployment to map out the deliberate replacement of humans by robots in the labour force as a way to produce more goods and services at a cheaper and faster rate (Acemoglu & Restrepo, 2020). In resistance to technological unemployment, Mashego (2022) found that in the 19th century, employees protested against industrialisation, technical developments and automation through a movement called Luddite, as a way to fight employers from assembling machines in place of human labour. Therefore, the replacement of human labour by technology has always been a fear issue for the working class (Mashego, 2022). Thus, on the account that researchers seek to deploy humanoid robots into classrooms, this study aims to investigate the different teachers' perceptions of the use

of robots in the classrooms and the possibility of unemployment that may be caused by robots in a South African context.

In this study, the term teachers' perception entails the quantified, analysed and interpreted common teacher beliefs, opinions and thoughts on the matter of inquiry. Doing this will enable the researcher to comprehend and identify patterns amongst different teachers' perceptions yielding generalizations. This applies to Démuth's (2013) observation that the quest to study and understand the world means to study perceptions and ideas created.

In context, the study was conducted in South Africa a country with socioeconomic diversities. Thus, this research report took into account school Quintiles. In South Africa, schools are ranked based on the unemployment rate and literacy rate of the community in which the school is located; with quintile 1 schools indicating poor/impoverished schools while quintile 5 indicates wealthy/affluent schools (Van Dyk & White, 2019). According to the South African Schools Act 84, section 2 (1996), Quintile 1 schools are classified as schools that cater to the poorest 20% of learners in the province and a non-fee-paying school; Quintile 4 schools cater to the least poor 40% of learners and a fee-paying school; and Quintile 5 school cater for the least poor 20% of learners and classifies as a fee-paying school.

1.2 Background

In a recent study, Mashego (2022) found that global scientists such as Bill Gates and Stephen Hawkins have cautioned that the implementation of technology into the labour market would lead to mass unemployment. According to research, automation is a major factor in job losses with an estimated 1.8 million jobs being declared to be automatable (Zhang, 2021). This implies that while automation is a bearer of economic sustainability, it yields displacement and increased unemployment.

However, Gong, Yang, Tan and Lu (2023) assert that there is a positive correlation between industrial robots and economic development. In their study, Gong et al. (2023) found that the data collected for 77 countries between 1993 and 2019 from the International Robot Federation, showed

that industrial robots have stimulated economic growth over the past twenty-six years. Therefore, drawing from Zhang (2021) and Gong et al. (2023) it is evident that the resurgence of the relationship between robots and employment strikes fear and anxiety for many people, with opinions on robots and employment divided between optimistic and pessimistic perceptions.

According to the Citi Global Perspective & Solutions (2015) report, Ethiopia, China, Thailand and South Africa are countries expected to face a high risk of job automation (Frey & Osborne, 2016). Badet (2021) proclaimed that jobs that are most likely to be automated are distinguished as low-level skills with repetitive tasks. Therefore, it is not surprising to note that Ferreira and Rossouw (2016) pinpoint that South Africa has an abundant supply of low-medium skilled workers and a shortage of high-skilled workers matching the labour demand. Hence, the rate of automation in South Africa is predicted to be considerably high amounting to 67 % as illustrated in Table 1.

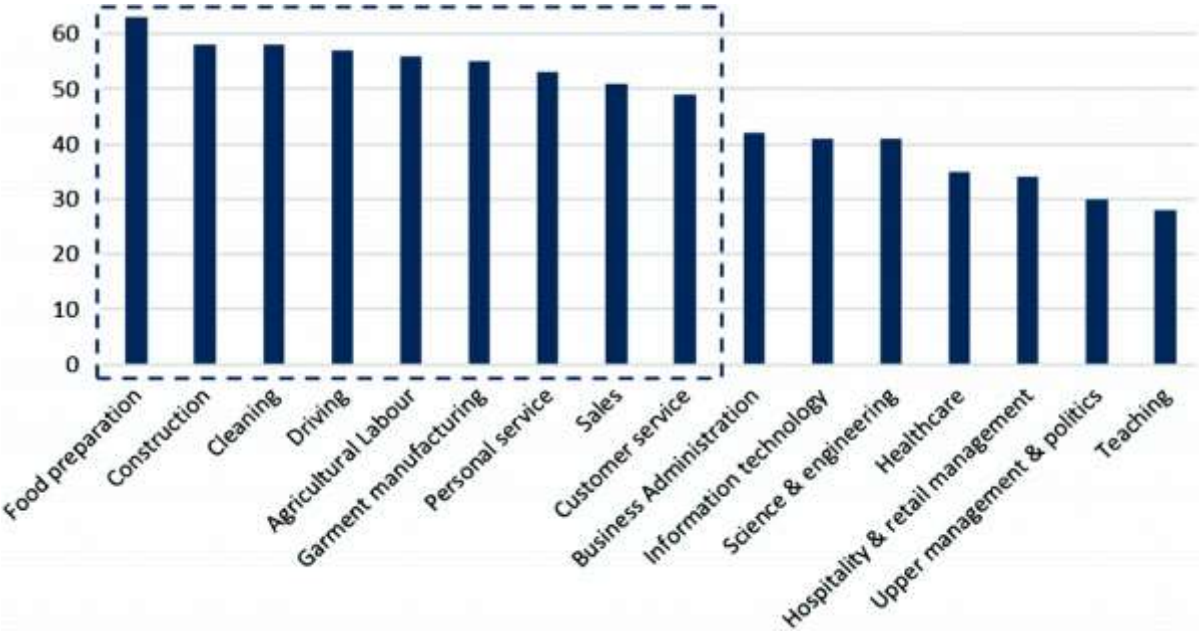
Table 1: Job Automation per Country

Country	**Automation Risks**
Ethiopia	85%
China	77%
Thailand	72%
South Africa	67%
Argentina	65%
Nigeria	65%
OECD countries average	57%
United States	37%
United Kingdom	35%

Source: adapted from Frey and Osborne (2016).

In the context of automation, the education sector is no exception. Palpably, predictions made by Professor Anthony Seldon, former Vice Chancellor of the University of Buckingham (Coelho, 2018) regarding robot teachers call for concern. Upon reviewing the book titled, '*The fourth revolution: Will artificial intelligence liberate or infantilize humanity?*' Coelho (2018) mentioned that Professor Anthony Seldon declared and predicted that in 10 years, teachers will be replaced by robots. Research supports the statements made by Professor Anthony Seldon (Coelho, 2018). According to a study conducted by the OECD, 14 % of jobs in 32 countries are vulnerable to the 4IR (Luco, Mestre, Henry & Tamayo, 2019). Surprisingly, among the sixteen job types identified (Luco et al., 2019) teaching is classified and estimated to have a rating of approximately 30% risk of automation. This illustration is demonstrated in Figure 1.

Figure 1: Automation by Job Types



Source: adapted from Luco, Mestre, Henry and Tamayo (2019).

The challenge presented in the contextual background of this study is concerned with the 67% of jobs that are declared to be at risk for automation in South Africa (Frey & Osborne, 2016). Additionally, according to existing research, teaching is no exception; as presented in Figure 1 (Luco et al., 2019; Coelho, 2018; and Ghaffari et al., 2019). As a result, the contextual background

is framed from the perspective of addressing the potential abilities and limitations of a robot in a classroom setting.

1.3 Problem Statement

According to research done by Brink and Wellman (2020), classrooms are increasingly incorporating robots to teach Languages, Mathematics, and Science. In some instances, robots are assisting teachers. On the statement of replacing teachers with robots, Ghaffari et al. (2019) highlight the opportunities and moral concerns of deploying robots in primary schools in the future. Notably, both these studies focus on how integrating robots in classrooms impacts teaching and learning, leaving a gap for analysing how integrating robots in a classroom impacts teacher unemployment and job insecurity as suggested in this study. The study further evaluated teachers' judgements on unemployment factored by the possibility of deploying robots in classrooms.

Ample studies have been done to understand what causes unemployment and how to minimize it at a global scale (Badet, 2021; Chiacchio, Petropoulos, Pichler, 2018; Campa, 2018) among others. However, this study was undertaken from the perspective of framing a South African context and the need to understand what discourses of teacher unemployment and automation are emphasised in existing literature. This is essential given that in 2021, an estimated 20 000 teachers mainly individuals with tertiary training in education, were reported to be unemployed (Shepherd, 2022c). Consequently, scholars such as Petersen and Batchelor (2019); Alhashmi, Mubin and Baroud (2021); Van Ewijk et al., (2020); and, Ekström and Pareto (2022) have recently gained interest in exploring the concepts of educational robots as highlighted above.

1.4 Purpose of the study

Aims

Drawing from a sociological lens, this study aimed to explore teachers' perceptions of unemployment caused by deploying robots into the teaching profession in South African schools. Furthermore, it aimed to investigate and explore how different factors, primarily gender, subject specialisation, age, different geographical locations of the school and school rankings (classified as quintiles 1, 4 and 5) influence teachers' perceptions of the practicality of employing robots teachers.

Objectives

Technological unemployment as stated by Maynard Keynes (Acemoglu & Restrepo, 2020) has been the by-product of robots replacing humans. Therefore, the objectives of this study were to:

1. Investigate whether teachers are concerned with the notion of technological unemployment within their field.
2. Investigate and explore the differences in teachers' perceptions regarding robots replacing teachers in classrooms in the future or b) deploying robots as teacher assistants.
3. Investigate teachers' perceptions regarding the relevance and practicality of deploying robots in South African schools to enhance quality education in the future.
4. Lastly, investigate how a variety of factors influence South African teachers' perceptions of deploying robots in schools.

1.5 Research Questions

The umbrella question posed in this study was: "What is the general perception of teachers regarding the use of robots in schools?" To address the aforementioned question the following sub-questions were asked:

1. Are South African teachers concerned about technological unemployment within the teaching profession?
2. What are the differences in teacher perceptions regarding robots replacing or assisting teachers in classrooms in South African schools?
3. How do different teachers perceive the relevance and practicality of employing robot teachers, instead of human teachers in the future?
4. How do different factors such as school quintile, and subject specialisation influence the teacher's viewpoint on deploying robots into South African schools?

1.6 Intended significance of the study

Research is a scientific and systematic search for knowledge and pertinent information, to solve a problem, generate new knowledge or contribute to existing knowledge (Kabir, 2016). Therefore, to align with Kabir (2016) in the context of teacher labour, teacher unemployment, automation and educational policies, this study intended to make theoretical, methodological and practical contributions (discussed in detail in chapter 6).

1.7 Theoretical framework for the study

In this section, the study discusses two subtopics that make up the theoretical framework of the study. One, structural functionalism as the sociological perspective and two the framework that models this theory.

1.7.1 Sociological Perspective: Structural Functionalism

Structural functionalism is a sociological perspective influenced by Herbert Spencer, Emile Durkheim and Radcliffe Brown (Nargiza, Zhao & Fazal, 2023). As a theoretical framework, structural functionalism seeks to explain and understand how a society works by examining the relationships between various social institutions (Nargiza et al., 2023). According to Adeosun, Bello and Aruleba (2022), the functionalism of society is dependent on the collaboration of the social institutions to attain social stability, continuity and structure. Social stability is achieved when social institutions such as the government, law, religion, education and norms work together to meet the needs of the citizens (Adeosun et al., 2022).

Structural functionalism, as a theoretical framework in sociology, does not consist of a single, unified and consistent exposition (Hudson, 1978). Rather, different writers and scholars emphasise different terminologies and phenomena under a variety of similar terms. On that notion, this study adopted Parsons's structural functionalism model of society. In their study, Podmenik and Gorišček (2020) suggested a theoretical model (Figure 2) to demonstrate the long-term effect of structural unemployment on social subsystems.

Assuming that a society has subsystems, functionalists assert that the youth as the smallest entity in the subsystem are connected to different communities, associations, institutions and the society as a whole with a certain level of mutual solidarity. As observed in Figure 2, subsystems are interconnected in the society meaning that collectively, all subsystems influence each other. Therefore, youth unemployment directly affects other subsystems. Hence, the increased rate of unemployment impacts other subsystems like education, national trends, the labour market, family dynamics and policies. For instance, globalisation in the form of 4IR influences international and national economic trends which may cause a change in the labour market. Consequently, this impacts the education subsystem to reproduce digitally literate youth matching the new skills needed in the labour market. This is normally informed by policy creation and policy implementation as a way for society to strive or address social ills (Christie, 2008).

1.7.2 Modelled Framework

Figure 2: Interconnected Sub-systems



Source adopted: from Podmenik and Gorisšek (2020).

Similarly, drawing from Parsons's structural functionalism model of society, this study sought to explain and understand the concept of social instability caused by technology and how technology impacts the social institutions of society. Czibere (2014) asserts that society is a complex mechanism that is entitled to distribute its members among different social positions and to distribute its members among different social positions and stimulate them to fulfil tasks associated with their function. This implies that deploying robots in place of human teachers will disrupt the functionalism of society by influencing other social institutions like policies, education and the government which can result in social unrest.

Therefore, this study was guided by a structural functionalist lens as adopted from Podmenik and Gorisšek (2020), to comprehend how the implications of deploying robots in classrooms would cause instability to social institutions like education, the economy, families, the State, and Government policies.

1.8 Delimitations of the study

The delimitations of this study entails the deliberate limitations and boundaries set by the researcher to ensure that the aim and objectives of this study are met (Theofanidis & Fountouki, 2019). This study was delimited to three secondary schools categorised as quintile 1 (School 1), quintile 4 (School 2) and quintile 5 (School 3) located in the Tshwane District, Centurion, South Africa. Secondly, the researcher sampled 45 respondents who were strictly employed at post levels 1 and 2 (PL1 & PL2). The reason why posts level 3 and 4 educators were not included is validated by their management roles. Their perception will be from a managerial perspective while the study aims to explore teacher's perceptions from a basic teacher's role of teaching any high school subjects. Lastly, the study relied on primary data obtained through a survey with closed-ended questions that are quantified for analysis, thus delimiting the relational research design and the scope of why each participant agrees or disagrees with the questions asked in the survey.

1.9 Limitations of the study

The limitations of this study refer to potential weaknesses that were out of the researcher's control when the research was conducted (Theofanidis & Fountouki, 2019). This study may be subject to threats of external validity (Connelly, 2013) due to four limitations: firstly, this was a small-scale study with a sample of three schools from the Tshwane district. Secondly, the quintile 1 and 4 school teachers were all black, while the quintile 5 school comprised of Black, Coloured, Indian and White teachers; outlining the factor of ethnicity, which was not part of the controlled variables. Thirdly, the period that the study was conducted was during exams and teachers were not easily available to partake in the study; lastly, the researcher's own biases which entails the researchers' expectations regarding the results and the expected teacher's perception.

1.10 Chapter Summary

The first chapter of this study outlined and provided an overview of the contextual background, aims, and objectives of why this research was conducted. The main goal was to introduce the reader to the concept of using robots in the classrooms and the possible impact on unemployment in a South African teaching context. The next chapter reviews existing conceptual and empirical literature on this topic.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature and journal articles to gather more insight into existing knowledge about teachers' perceptions of robot teachers. The study reviewed both theoretical and empirical literature on research studies conducted in the field of inquiry regarding robots and their impact on education and employment. There are seven main sub-topics in this literature review: technological advancement; exploring the concept of unemployment caused by technological advancement; automation; analysing the teacher labour market; job insecurity; empirical studies on teacher perceptions of robots; and the theoretical framework. The objective of reviewing both theoretical and empirical studies was to allow this study to gather an in-depth variation of methodologies on the concept of robots and how it is perceived by different scholars as well as drawing from their findings. Also, the purpose was to identify any gaps that exist in the literature about this topic.

2.2 Technological Advancement

The concept of robots emerged in the early 1920s as a science fiction play by Karel Capek titled Rossum's *Universal Robots* (Steijn, Luiijf, & van der Beek, 2016; Steijn et al., 2016; Sims, 1987). An early conceptualisation of a robot, as defined by Sims (1987) entailed an electronic device that performed tasks ascribed to humans through automatic controls; while the term robotics outlined the study of the robot construction, maintenance and behaviour. According to recent literature, the concept of robots has permeated social lives and is perceived as embodied, autonomous entities that can communicate and enter into social relations with people (Malinowska, 2021).

The earlier definition (Sims, 1987) associates robots with industrial spaces, whereby robots are built for factory frontlines to improve productivity. While the latter recognises robots in the consumer space, built to interact with humans. Over the last generations, robots have evolved from

being fully operated by a human to semi-autonomous, and currently, some robots are fully autonomous.

The term Technological advancement from an industrial perspective, entails the entire system of knowledge, organization, and procedures required to produce more outputs in any manufacturing process while maintaining the same number of inputs (Younus, 2021). In essence, it outlines progress, efficiency and productivity through the use of technology.

The term technological advancement as a by-product of Productivity and efficiency can be dated as early as the 1960s when robots were built to protect humans from dangerous tasks, using machines like the fixed-arm robot programmed to perform a repetitive task (Sims, 1987). According to Tarantino (2022) some jobs are too dangerous and impossible for a human to perform; therefore, a robot is the best option to achieve the desired task. For instance, some of the jobs performed efficiently by robots include lifting heavy objects; stirring molten metal at 2 000℃, packing and collecting radio-active waste, working in contaminated areas and performing strenuous repetitive motions (Tarantino, 2022). In the context of progress, Lima et al. (2021) assert that new technologies are created to foster innovations such as driverless cargo trucks, Artificial Intelligence (AI) mortgage analysis and AI paralegals.

Literature shows that other scholars provide a counterargument that associates technological advancement with unemployment, rather than productivity. While robots are created to protect and assist humans solve societal problems, Mashego, (2021) found that many occurrences such as the Luddite movement created technological unemployment intensifying famine and hunger among the peasants. The Luddite movement was a protest against technological advancement that took place in France; whereby the working class were resistant to the use of machines in manufacturing companies, seeing that their skills were classified as redundant (Mashego, 2021; Manuel, 1938).

Over the years, the integration of Technology in education has had an impact on teaching and learning. The current advancement includes the growing concept of using AI and the development of social robots to teach or assist teachers. Although there are significant variances in looks and technology, social robots are made to execute social duties as humans (Konijn, Smakman & Van den Berghe, 2020). They are frequently outfitted with eyes, motions, gestures, noises, and voice technology, similar to those of animals or humans (Konijn, et al., 2020).

According to Konijn, et al. (2020), there are three types of robots used in education, mainly the 'build' and 'use' robots which are used as tools for learning to construct robots, learning programming skills, and learning about robots. The most dominant scholar within the field of building and using robots is highly attributed to the scholar Seymour Papert; whose vision entailed the use of LEGO to improve learners' metacognitive abilities, particularly in the early stages of school (Gillespie, 2004).

The third type of robot, known as 'social robot' is used to deliver a learning experience through social interaction with learners. Of the three robot types used in education Konijn, et al. (2020) argue that "Compared to other e-learning devices, the physical presence or embodiment of social robots appears most advantageous (p. 2)". This implies that, since humans are considered social beings, the notion of interacting with an actual robot machine creates an atmosphere of companionship between the robot and the humans enabling alternative methodologies for teaching and learning.

2.3 Technological Unemployment

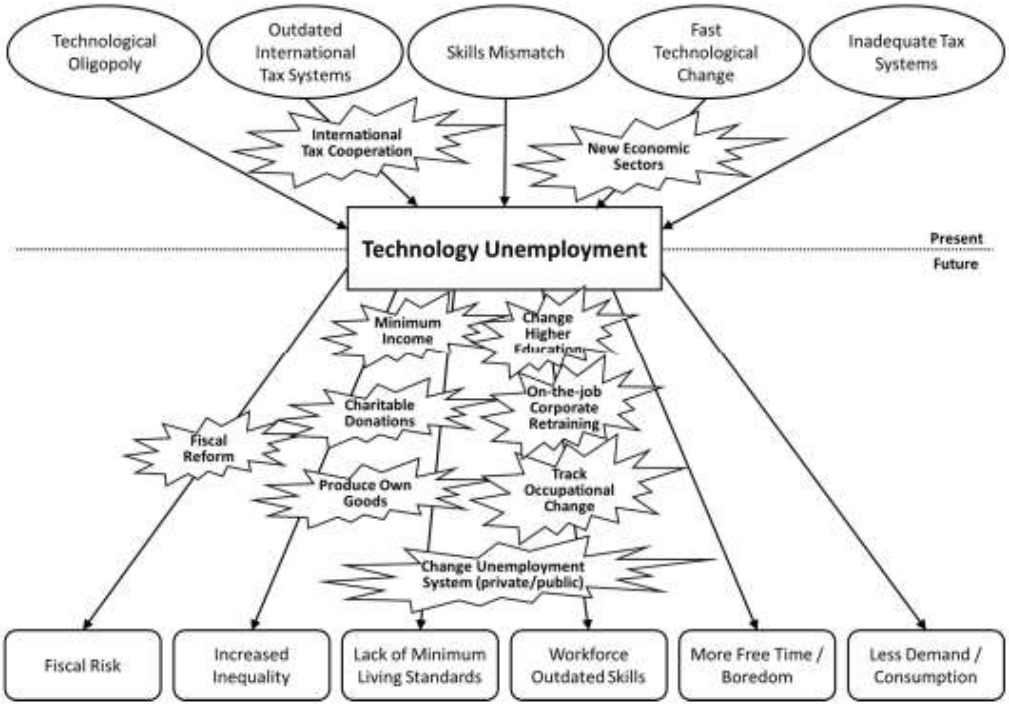
In 1929, John Maynard Keynes (Frey & Osborne, 2017; Acemoglu & Restrepo, 2020) predicted unemployment as a by-product of rapid advancement and automated technology becoming the bearer of economic sustainability. Referring to this notion, Maynard Keynes invented the phrase *'Technological unemployment'*, a phrase defining the deliberate replacement of humans by robots in the labour force (Frey & Osborne, 2017; Acemoglu & Restrepo, 2020). To validate this prediction, Chiacchio et al. (2018) concluded that technological innovation can affect employment by directly relieving the worker of their duty and replacing them with a machine to enhance production, a process known as the *Displacement effect*.

In addition, Chiacchio et al. (2018) noted the *Productivity effect*, to further argue that technological innovation consequently creates a new platform of labour which seeks new skills to match the new demand. Alternatively, Hötte, Somers, and Theodorakopoulos (2023), defined the relationship between *Displacement* and *Productivity effect* as *replacement* and *reinstatement effect*.

The concept of unemployment is a Universal problem attributed to multiple factors and social injustices. Several scholars (Chiacchio et al., 2018; Mashego, 2022; Acemoglu & Restrepo, 2020; Gong et al., 2023) articulate that technological advancement and automation are the cause of unemployment, and this will be intensified in the future.

In a study titled, '*Understanding technological unemployment: a review of causes, consequences, and solutions'*, Lima, Barbosa, Dos Santos and Souza (2021) constructed a framework based on reviewed literature concerning technological unemployment as depicted in Figure 3 below. The study conducted by Lima et al. (2021) outlines current events that will result in technological unemployment in the future.

Figure 3: Technological Unemployment, Causes and Consequences



Source adopted: from Lima, Barbosa, Dos Santos and Souza (2021).

Briefly, according to Figure 3 (adapted from Lima et al. [2021]), there are five Causes of technological unemployment influenced by current systems. Firstly, *Technological Oligopoly*

refers to technological development that will disrupt the worldwide labour markets led by the USA and China's biggest companies. Lima et al. (2021) argue that big Companies like Amazon, Apple, Facebook, IBM, Google and Microsoft maximise profits that benefit mainly the USA and China, while developing countries are impacted by technological unemployment.

In line with Lima et al. (2021) statement, Mashego (2022) found that in the 1950s Chrysler, Ford and General Motors were considered the three big automotive companies, with a combined revenue of $36 billion employing close to a million workers. However, the current big three companies Apple, Facebook and Google collectively exceed a trillion dollars in revenue but only employ 311 000 employees (Mashego, 2022). Thus, it is clear that the number of employees employed in big companies has decreased over time masking a decrease in human capital.

The second factor that will cause technological unemployment is Outdated International Tax Systems (ITS). Lima et al. (2021) assert that the International Tax systems are stagnant in solving inequalities between developed and developing countries. Some of the main challenges arise from digitalisation and corporate income taxes across countries.

Thirdly, skills mismatch is another factor eroding the demand for human skills; creating a demand for high-level skills due to the ever-changing digital world (Lima et al., 2021). Similarly, Ferreira and Rossouw, (2016) argue that the challenge of introducing technology into various sectors of the economy shifts away from the demand for low-medium skilled candidates to a need for highly skilled candidates which results in a mismatch of skills and increased unemployment rates.

For instance, Allais (2022) argues that the South African economy is stagnant due to a skills crisis and the failure of organizations to align the desired skills with work expectations. According to Ferreira and Rossouw (2016), South Africa has an abundant supply of low-medium skilled candidates which causes what Dore coined '*Diploma Disease'*, while Collins coined it '*Credentialism'* (Shalem & Ramsarup, 2020). This indicates that the country's failure to adapt and equip workers with skills aligned with new technological needs in the labour force will result in unemployment (Chiacchio et al., 2018).

The fast technological change is the Fourth factor contributing to a constant change in the job demand and labour market (Lima et al., 2021). Lastly, the current tax system charges more labour than capital, thus resulting in inadequate tax systems that collect less tax for automated production

in comparison to humanised production (Lima et al., 2021). Consequently, the five factors considered above contribute to the consequences listed by Lima et al. (2021) such as fiscal risk; increased inequalities; lack of minimum living standards; workforce outdated skills; boredom and; less demand.

According to recent research, critics state that full automation of the labour process in organizations is science fiction because the limitations of technology have been underlined to rationalize their discourse (Dandalt, 2021). Furthermore, Dandalt (2021) states that many activities performed by robots are limited since the scientists who create the software for these machines are unable to specify the rules required to do each task. Therefore, it is safe to say that, technological unemployment is not a threat to the teaching profession for as long as the hardest tasks to automate have been those that require common sense, flexibility, sound judgement, and skills that we only have a tacit understanding like teaching (Dandalt, 2021).

In addition, Dandalt (2021) argues that to date, teacher unions have not prioritized the fight against automation since the course to replace teachers with robots is at an early stage of development and it does not pose a threat to teachers' job security. However, automation might become a contentious issue shortly if legislators and corporate elites utilize it to restrict teachers' rights to collective bargaining and de-unionize public education.

2.4 Automation

In the subsections below, the term automation is discussed in detail and as the most dominant scholars in the field of automation this subsection further analyses the Frey and Osborne (2013) study. Secondly using Owen-Hill's 4D criteria for automation, this subsection explores how jobs are predicted to be at risk for automation (Tarantino, 2022).

2.4.1 Job Automation

In this study, Automation entails the use of self-regulated robots to perform tasks more efficiently than a human. Goldberg (2012) stated that Automation emphasizes efficiency, productivity, quality, and reliability, focusing on systems that operate autonomously. Meaning that there is minimum human input needed. Within the field of automation, technological advancement and technological unemployment, the study conducted by Frey and Osborne (2013) has been highly referenced. Their study resurfaced the fears of technological unemployment in public discourse, probing policymakers and researchers to respond to these concerns. They sought to gain a more nuanced understanding of the future of work (Frey, 2021); resulting in two approaches whereby some scholars agree with Frey and Osborne (2017) while others critique their study.

In this context, Frey and Osborne (2017) assessed the automatability of job tasks using the national labour data and were able to estimate the percentage of jobs susceptible to automation (Arntz, Gregory & Zierahn, 2016). In their study, Frey and Osborne (2017) estimated that about 47 % of total U.S. employment was categorised as potentially automatable over some number of years. Frey and Osborne (2017) study contributed to existing literature and their methodology has been replicated in different studies as a way to assess *occupational automatability*, which entails characterising jobs at risk of being automated based on the entire occupation rather than the tasks performed on the job.

Similarly, Frey (2021) found that in countries like Germany, scholars such as Carsten Brzeski and Inga Burk replicated their methodology and concluded that 59% of jobs in Germany might be at risk. In Europe, the Leibniz Centre for European Economic Research used a similar model and lowered the automation risk from 47% as suggested by Frey and Osborne's (2017) study to 42% (Frey, 2021).

However, Arntz et al. (2016), argue that this model might lead to an overestimation of the actual jobs that are considered automobile because the study of Frey and Osborne (2017), considers the entire job occupation, rather than single job tasks. In addition, Arntz, et al. (2016), noted that the occupations labelled as high risk of automation often still contain a substantial share of hardly automated tasks. In their study, using a task-based approach, Arntz et al. (2016) found that on average, for 21 OECD countries, only 9% of jobs are indeed automatable.

Overall, there are two main critiques against Frey and Osborne (2017): firstly, that they vastly exaggerated the technological potential for automation and that their study assumes the cause and effect of job automation (Frey, 2021). Secondly, scholars argue that their study attempts to predict how many jobs will be lost in the future, which sounds exaggerated.

In the subtopic below, this study reviews criteria that help determine job automation.

2.4.2 Automation Risk

The replacement of human labour by technology has always been a fear for the working class (Mashego, 2022). Therefore, it is crucial to comprehend which criteria are used to determine the need for job automation. Owen-Hill (Tarantino, 2022) proposes the Dull, Dirty, Dangerous and Dear (also known as 4D's) criteria as a method to identify the most common characteristics of jobs that are at risk of being automated. To elaborate, the 4D's are discussed below:

1. **Dull** – Tasks that are not mentally stimulating for a human (e.g., loading identical parts into a conveyor).
2. **Dirty** – tasks that are dirty and messy for humans to perform.
3. **Dangerous** –the tasks that can endanger a human's life.
4. **Dear** – the tasks that are more expensive when performed by humans.

From a broad perspective, Le Roux (2018) proposes that about 50% of South African workers, or 7.08 million individuals are employed to carry out the 20 most prevalent job kinds, as seen in Figure 4. Using Owen-Hill's 4D criteria (Tarantino, 2022), this study categorised the most Prevalent jobs found in South Africa as indicated in Table 2.

Figure 4: South African most common Jobs.

Occupation	2008	2014	Change	% Change
Domestic helpers and cleaners	1,075,993	1,030,588	−45,405	−4%
Farmhands and labourers	834,886	905,965	71,079	9%
Other office clerks and clerks not elsewhere classified …	373,351	521,360	148,009	40%
Helpers and cleaners in offices, hotels and other …	475,298	511,056	35,758	8%
Shop salespersons and demonstrators, …	393,841	455,255	61,413	16%
Protective services workers not elsewhere classified …	346,118	438,888	92,770	27%
Hand-packers and other manufacturing labourers	396,023	396,684	661	0%
Street food vendors and related workers	437,589	317,885	−119,704	−27%
Cashiers and ticket clerks	260,218	285,530	25,312	10%
Primary education teaching associate professionals	282,719	268,257	−14,463	−5%
Cooks	172,314	264,491	92,177	53%
Bricklayers and stonemasons (including apprentices/trainees)	275,735	225,366	−50,369	−18%
Heavy truck and lorry drivers	210,677	215,692	5015	2%
Sweepers and related labourers	45,688	205,293	159,605	349%
Teaching associate professionals not elsewhere classified	233,046	190,313	−42,732	−18%
Construction and maintenance labourers: roads, dams …	207,132	176,711	−30,420	−15%
Police officers, traffic officers …	127,190	173,709	46,519	37%
Motor vehicle mechanics and fitters	193,122	173,350	−19,772	−10%
Finance and administration managers/department managers	137,795	172,019	34,225	25%
Street vendors, non-food products	143,638	160,110	16,472	11%
	6,622,371	7,088,521		

Table 2: Automation classification.

	Job type
Dull	Farmhand & Farm Labourers
	Hand-Packers
	Manufacturing Labourers
	Cleaning
	Cashier & Ticket Clerk
Dirty	Vehicle Mechanics

Dangerous	Construction & Maintenance
	Heavy Truck & Ivory drivers
	Bricklayers
	Security
Dear	Farmhand
	Salesperson
	Domestic Helpers
	Clerk
	Protective security
	Teaching
	Food vendors
	Police
	Finance & admin
	Teaching assistance professionals

In the context of assessing the teaching profession utilising the Owen-Hill 4D criteria is not a linear task. Given the categories Dull, Dangerous and Dirty, it is evident that the teaching occupation does not fit these job descriptions. Hence, the ultimate option is Dear. However, applying Arntz et al. (2016) proposal to evaluate job automation risk using specific job tasks rather than the entire occupation; it is evident that teachers perform complex tasks (providing emotional support, maintaining discipline, extra-curricular activities, etc [Pam, 1998]) Therefore, this study argues that the criteria Dear does not substantially validate that teaching is susceptible to automation.

2.5 Teachers

This section addresses the teacher labour market and the current development of robot teachers. The first subsection explores existing challenges and opportunities found in the teaching labour market for human teachers. The second subsection analyses the development, limitations, and existing robot assistants/teachers.

2.5.1 Teaching labour market

In their study, Edwards and Cheok (2018) made a call for robots and AI machines to be deployed as a solution for teacher shortages. According to Edwards and Cheok (2018), in the US teacher shortage is a crisis caused by job dissatisfaction, lack of recognition, and poor remuneration/advancement, amongst other things. Hence, about 46% of teachers move and leave the teaching profession (Edwards & Cheok, 2018). While certain scholars like Sharkey (2016) object to the concept of robots replacing human teachers in totality. Edwards and Cheok (2018) argue that it is too early to conclude robot teachers. They state that independent robot teachers are a possibility for the future, to solve the teacher shortage crisis and many more shortfalls by human teachers.

However, according to Bennell (2023); Mapepa and Adekoye (2019); and, Mbokazi et al. (2023), teacher unemployment is a great concern for many Sub-Saharan (developing) countries. In 2021, Kenya had an estimated 300,000 out of 755,000 teachers who registered with the Teacher's Service Commission and were looking for a teacher vacancy. Similarly, countries like Zambia, Malawi, Ghana, Lesotho and Swaziland faced similar trends due to economic constraints, environmental factors and in some cases political conflicts (Bennell, 2023).

Drawing from Edwards and Cheok (2018) the subtopic below explores the practicalities of using a robot teacher or assistant by analysing the limitations and potential capabilities of actual robots that were built to teach in different countries.

2.5.2 Robot teachers

In the case of using robots in classrooms, Sharkey (2016) found that out of the 27 000 people who took the European survey, 34% believed that robots should be banned from the field of education; 60% thought that robots should not be allowed to care for children; while only 3% of the sample population agreed to use robots in education.

According to Sharkey (2016), the disadvantages of using social robots in classrooms are the need for ethical concerns, privacy, attachment, deception and loss of human contact. Alternatively, the advantages of using robots are that they outperform humans, perform dangerous tasks that humans cannot, have technological advancement and are more effective than humans (Sharkey, 2016). To comprehend the limitations and abilities of robots, Table 3 summarises tasks performed by different robots in a classroom context:

Table 3: Robot teachers and assistants.

Robot Teacher	**Activities**	**Author**
Robot SAYA  Source adapted from: Hashimoto et al. (2011).	***Model year: 2004*** ***Country***: Japan ***Objective*** Generating natural facial expressions similar to humans to improve physical and emotional interaction with learners. Articulate brief sentences and accompany them with an appropriate facial expression ***Role: Teacher***	Sharkey (2016). Hashimoto et al. (2011).

	Remote-controlled humanoid robot with a female appearance programmed to teach principles of leverage and introduce learners to robotics. Interact with learners through different facial expressions. ***Limitations*** • Lack of movements. • No ability to converse beyond a given scenario. • Was more accepted by elementary school kids and not university students.	Hashimoto et al. (2006)
Robot Rubi  Source adopted from; Movellan, Tanaka, Fasel, Taylor, Ruvolo and Eckhardt (2007).	***Model year:*** September 2004 (2 years development) ***Country***: Singapore **Objective:** Improving toddler's vocabulary skills. **Role**: Autonomous /Tutor A robot technology that can interact with toddlers by singing and dancing; Rubi could engage with learners through physical games and play Flash-based educational games targeting vocabulary development.	Sharkey (2016). Movellan et al. (2007)

	Limitations • Hardware and software architecture needed improvement beyond the developer's scope. • Prioritized self-locomotion rather than social interaction.	
Softbank's Pepper  Source adapted from: Tanaka, Isshiki, Takahashi, Uekusa, Sei, & Hayashi (2015).	**Model year:** 2014 **Country**: France/ Japan **Objective**: Designed for human interaction. It is equipped with voice, gestures and emotion recognition. **Role** Teaching Assistant Designed to provide care-receiving robot & total physical response. Developed with autonomous behaviour through speech, and emotional recognition function. **Limitations** • Lack of adaptability. • Limited room for triangular interaction between teachers, learners and the robot.	Groot (2018). Tanaka et al. (2015)
Robot NAO	**Year:** 2006 **Country:** France	Orhani (2023).

 Source adapted from: Orhani (2023)	**Objective:** **Role: Teacher/Assistant** Multilingual Support speech recognition for 20 languages. Provides content and enables small-group or one-on-one personalized learning activities. Provides multiple learning modalities (visual, auditive and kinaesthetic) Focuses on STEM subjects. **Limitations**: • Technical errors	Robaczewski, Bouchard, Bouchard and Gaboury, (2021). Robaczewski et al., (2021)

The reason behind using robots in classrooms stems from the notion that robots increase students' motivation, engagement and concentration. Hence, when a robot is designed to act as a social agent, it assumes the role of a peer, learning companion, tutor, teacher's assistant or teacher (Ekström and Pareto, 2022). Another reason why research on educational robots is continuously gaining popularity is based on the fact that scholars argue that the integration of robots aims to improve teaching and learning. Wang, Sang, Huang & Gou (2023) stipulate that:

> The application of educational robots is consistent with several contemporary learning theories such as principles of active learning, social constructivism, and Papert's constructionism theory. Some evidence is available that the use of robotics in education has a positive impact on student behaviour and development, especially in problem-solving skills, collaboration, learning motivation, participation, and enjoyment and engagement in the classroom (p.2).

2.6 Job insecurity

Job insecurity has been a matter of concern across multiple disciplines. According to Shoss (2017), transformative technology and economic and political changes are the drivers behind social instabilities and distress. The reason is that job insecurity reflects a threat to society and the labour market. On the notion of job security, teaching has always been regarded as one of the most secure occupations. This is on the basis that during the mid-1980s recession, teachers were not affected by legitimized layoffs (Rosenblatt & Ruvio, 1996).

However, using a bibliometric analysis of the scientific web of science on job insecurity perceived by teachers in pandemic situations, Gómez-Domínguez et al. (2023) found that scholars have recently shown interest in the topic of teacher insecurity trend, hence it had an upward annual growth of 41.52% over the years. In this study, job insecurity is explored on account that the concept of technological unemployment causes job insecurity for the working class (Mashego, 2022). Therefore, in the context of teacher unemployment, it is crucial to understand what causes job insecurity and to what extent.

Amongst the various contestations regarding what job insecurity truly entails, Shoss (2017) defined job insecurity as a perceived threat to the continuity and stability of employment as it is currently experienced. Similarly, Keim et al. (2014) assert that from a global perspective, job insecurity is concerned with the continued existence of a particular job. To explore why employees, worry about losing their jobs, Keim et al. (2014) found that the degree of job insecurity is subjective, thus varies from person to person. Lower levels of job insecurity are associated with minor factors such as role conflict, internal locus control, and less organizational change. While moderate job insecurities were associated with factors such as age difference and difference in qualifications.

2.7 Empirical Studies on Teacher's Perceptions

This section is divided into three subsections that dwell on empirical literature addressing teachers' perceptions of robots. The studies discussed in these subsections below are empirical and their methodologies differ. However, the common findings show how teachers feel regarding robots in different contexts. The first subsection critically analyses international studies. The second subsection addresses a South African study. In response to the reviewed international and RSA local studies, the third subsection critically engages, analysis, and compares the overall findings of the empirical pieces of literature.

2.7.1 International scope

This section reviews three international studies from different countries. Each study is crucial for this research report on account that different scholars utilized different approaches to explore the concept of teacher perception on robots.

Study 1

Ekstrőm and Pareto (2022) recently conducted a study that explored teachers' perceptions of a learning activity where a child engaged in a Mathematics game with a humanoid robot. The activity was based on a robot acting as a tutee while the student was assigned the role of a tutor. The research assessed how teachers perceived the robot in this child-robot learning activity. The aim of the study was for the child to learn by teaching, a concept where children acquire knowledge by teaching others, in this case, a robot (Ekström & Pareto, 2022). Therefore, unlike most studies that assign the robot a teaching role, this study assigned the student the role of a tutor, while the robot was assigned a tutee role.

The study used a mixed methods approach and comprised eight stages (Ekstrőm and Pareto, 2022). In the first stage, Ekstrőm and Pareto (2022) approached 79 teachers who never worked with a robot and only 17 responded. The respondents (teachers) were asked to watch a video clip of a child-robot game-playing session and then tasked to answer a web-based questionnaire. The second and third stages involved teachers attending a teacher development workshop at the

university organised by Ekstrőm and Pareto (2022) where teachers were exposed to a live demonstration of a human-robot interactive dialogue. In stages four and five, 14 teachers experienced a presentation and a video clip. In stage six, teachers experienced a live interaction between the student (Tutor) and the robot (Tutee). Lastly, in stages seven and eight, the teachers were interviewed regarding their observations on the teaching between the student and the robot.

Ekstrőm and Pareto (2022) found that teachers believe that the use of social robots can stimulate relevant skills and support curriculum objectives. Furthermore, teachers view robots as didactic tools and social actors. This implies that teachers believe that robots are a tool to enhance teaching and learning activities. However, Ekstrőm and Pareto (2022) further found that teachers felt the activity was slow and cumbersome to complete. Thus, at times, teachers felt the need to assist the student and robot interaction. Most importantly they also found that the robots' technical shortcomings were a limiting factor for social interaction.

Study 2

Van Ewijk, Smakman and Konijn (2020), conducted a study on a focus group of 18 teachers across primary schools in the Netherlands to gather their perspectives on concerns and opportunities related to educational robots. The sample comprised 10 female and 8 male teachers of which 5 teachers were from a junior section, 8 teachers teaching in a middle section, with 4 teaching in a senior school. The sample was selected based on age (29-59 years), teaching experience (1-37 years), and most importantly the classification between teachers that had experience working with educational robots such as LEGO Mindstorms or Dash and Dot.

The first session conducted included a neutral presentation explaining social robots and moral values, Afterwards, a group discussion was held where teachers discussed with each other and wrote down their findings (Van Ewijk et al., 2020).

In their findings, Van Ewijk et al. (2020) observed that teachers shared multiple opinions on the challenges and opportunities of having social robots within schools. Although most teachers were enthusiastic about using robots, they acknowledged that robots did indeed assist learners with language and maths. However, there were concerns regarding privacy and security.

Study 3

In contrast, Alhashmi, Mubin and Baroud (2021) researched teachers' and student's perceptions of teaching robots as an assistant teacher in an Arabic context. Alhashmi et al. (2021) randomly selected a sample of teachers (n=5) and learners (28) from public government schools in Abu Dhabi and employed a qualitative research study through focus groups. The data collected comprised pre and post-test scores and all the student interactions with the robot were captured as video recordings.

Alhashmi et al. (2021) found that on a scale of 1 to 10, learners at most rated a 10, indicating that they enjoyed the session of interacting with a humanoid teacher assistant. In addition to this rating, all learners assumed that robots do not make mistakes. The overall deductions drawn from the robot humanoid as a teaching assistant, is that learners were more enthusiastic and excited to have engaged with a robot while the teachers on the other hand "tended to think of robots as more of a work in progress with several unaddressed questions in their minds (Alhashmi et al. 2021 p.254)".

2.7.2 Local Scope-South Africa

In South Africa, research studies conducted to evaluate teachers' perceptions of technological unemployment and deployment of automated robot teachers are very scarce because many of these studies are conducted in economically advanced and developed regions (Adukaite et al., 2017).

Batchelor and Petersen (2019) argue that the complexities of teaching cannot be reduced to simple algorithms. Through a qualitative study conducted by Petersen and Batchelor (2019), they investigated pre-service teachers' views on robots replacing teachers in South Africa by exploring the concept of teacher judgement. The sample of pre-service teachers was mainly selected based on the integration of ICT as their main course or as a part of their specialization.

They created an online competition whereby student teachers answered two questions on artificial intelligence and robot teachers.

The study's findings prove that teachers cannot be replaced by robots based on the complexities of teaching. Despite this, the findings from the pre-service teachers were mainly concluded as

naïve based on the failure of students to acknowledge the different types of teacher knowledge. Another conclusion drawn from the data collected highlights that humans are the only entities capable of providing emotional support and well-being. In conclusion, Batchelor and Petersen (2019) acknowledged the advantages of using AI and robots to assist teachers with some of the complex series of teaching. Although pre-service teachers acknowledged that human teachers are essential for various complexities of the role**.**

Overall, all three intranational studies on robot teachers (Alhashmi et al., 2021; Ekström & Pareto, 2022; Van Ewijk et al., 2020) utilised a robot model in their study, unlike the local South African study (Batchelor & Petersen, 2019). Even though the research objectives and designs of all three international studies were different, the main focus was directed at ensuring that teaching and learning take place.

2.7.3 Overview of Perceptions

This subsection compares and contrasts the studies reviewed above on teacher perceptions. The two main themes are based on critics and the opportunities associated with using robots in classrooms.

Critics against deploying robots

A) Human Capacity development

The main objections reviewed in this study are related to the study's focus on addressing teacher employment and unemployment caused by robots. This is because academics contend that from the standpoint of labour relations, trade unions and educators will be against the idea of using robots. According to Dandalt (2021), teacher trade unions have consistently resisted threats to their members' interests and have taken action to remedy them. Thus, it is not surprising to note that Dandalt (2021) argues that trade unions will oppose these changes on the account that deploying robots as a form of technological advancement will cause conflict with teachers' objectives.

The opposition (trade unions and teachers) would stem from the fact that teachers invest their time and money to attain the knowledge and skills required to become teachers. Thus, replacing teachers with robots would then entail that their expertise and skills are deemed redundant and irrelevant probing the conflict of interest between teachers and the government as the employer (Acemoglu & Restrepo, 2020).

On that note, when teacher's skills are deemed redundant and irrelevant this would then mean that tertiary institutions would have to discontinue the Bachelors of Education (B.Ed.) programme and the Post Graduate Certificate of Education (PGCE) programme in response to the labour market, budgetary and financial constraints impacted by low enrolments for the teaching programme. Thus, deploying robots not only impacts the teachers rather it has an indirect influence on educational institutions like Universities and Colleges.

B) Unemployment and Displacement

Benchmarked to the events of the Luddite movement, the product of deploying robot teachers would result in teacher displacement as suggested by Chiacchio et al. (2018). Inversely, teacher technological unemployment. From a sociological perspective, the latter event will have a daunting ripple effect on many facets of society given that teacher unemployment impacts the teacher's family dynamics, the teacher's social contribution to society and economic growth.

C) Socioemotional wellbeing

Dandalt (2021) and Sharkey (2016) both indicate that the inclusion of robots will have a detrimental impact on learners' emotional and psychological well-being. This notion emphasises the technical limitations of robots and raises concerns for the learner's well-being.

D) Asymptotic ideals

The concept of robots ever replacing teachers in totality is statistically improbable. These arguments are substantiated by the discourse of robot interdependency on humans and the

lack of precision. Drawing from Dandalt's (2022) argument, people who design and construct these robots, are often unable to specify the rules required by the robot to perform each teaching task with precision. This implies that, the scientists that make these robots can only assume what the role of a teacher entails. However, their scope is limited given that the role of the teacher is never uniquely defined, rather it is influenced by many factors such as cultural context, environment and the interaction with learners (Makovec, 2018).

Hence, Petersen and Batchelor (2019), argue that the complexities of teaching cannot be reduced to simple algorithms, meaning that the concept of robot teachers presents asymptotic patterns. To elaborate, asymptotic patterns resemble an analogy to comprehend the probability of replacing human teachers with robot machines. The analogy highlights the abilities of a robot and acknowledges the improvements of the robot through experience (More data). However, due to the technical limitations of the robot, the idea of replacing humans becomes impossible even in the future.

E) Decolonising Technology

According to research, the role assumed by the teacher is mainly influenced by internal or external factors (Makovec, 2018). Whereby internal factors are derived from the teacher's perception and beliefs of what it means to be a teacher. External factors are derived from the teacher's interaction and expectations from all stakeholders (learners, colleagues, parents, and principals). Therefore, given that a robot is a product of prewritten instructions of programming, this means that the internal factors of the robot will portray the beliefs and perceptions of the scientist who created it. On the account that Marwala (2018) asserted that technological devices mirror American and European norms, it is worth noting that from an African context deploying robots built in America or Europe will probe Westernized norms in African classrooms, yet again excluding African context.

To illustrate how the biases of the makers can be projected onto learners in a classroom, it is worth reflecting on Marwala's critics of technology and AI. Professor Tshilidzi Marwala

(2018) the former vice-chancellor of the University of Johannesburg; based on his experience of utilising the speech-recognition-system-based search device highlighted that the device pronounced his name using an American accent leaving room for stereotypes against African accents. This is because the data used to train this device is largely collected from North America and not South Africa (Marwala, 2018). Therefore, these finding mirrors the stereotypes of the makers of the device.

Alternative view

Dandalt (2021) found that many teachers saw the use of data as an opportunity to enhance personalised learning experiences. While Van Ewijk et al. (2020) found that the overall excitement of working with a robot was also seen as an opportunity to spark new interests within the pupils. This aligns with the Alhashmi et al. (2021) empirical study, which justified that most learners enjoy interacting with a humanoid teacher assistant.

Both studies conducted by Ekström and Pareto (2022) and Van Ewijk et al. (2020) highlight the shared belief among teachers. Their studies emphasize the use of social robots as stimulators of relevant skills that support the curriculum. This is supported by Brink and Wellman's (2020) argument regarding the increase of robots to teach Languages, Mathematics, and Science in classrooms.

2.8Theories

This section discusses the theories used in the research report. There are two main subheadings themed as the theoretical framework and theoretical models.

2.8.1 Theoretical framework

In this study, a theoretical framework is defined as concepts or principles from which the researcher draws as a base to analyse the concepts of technological unemployment, technological

advancement and job insecurity (Kivunja, 2018). The use of a theoretical framework serves as a blueprint to align this research study with an existing theory that allows the researcher to analyse and interpret data on teacher's perceptions (Adom et al., 2018).

According to Talcott Parsons, structural functionalism seeks to explain and understand how society works by examining the relationships between society and various social institutions (Nargiza et al., 2023). This implies that Parsons' structural functionalism provides a descriptive framework of society, its systems and its interconnectedness.

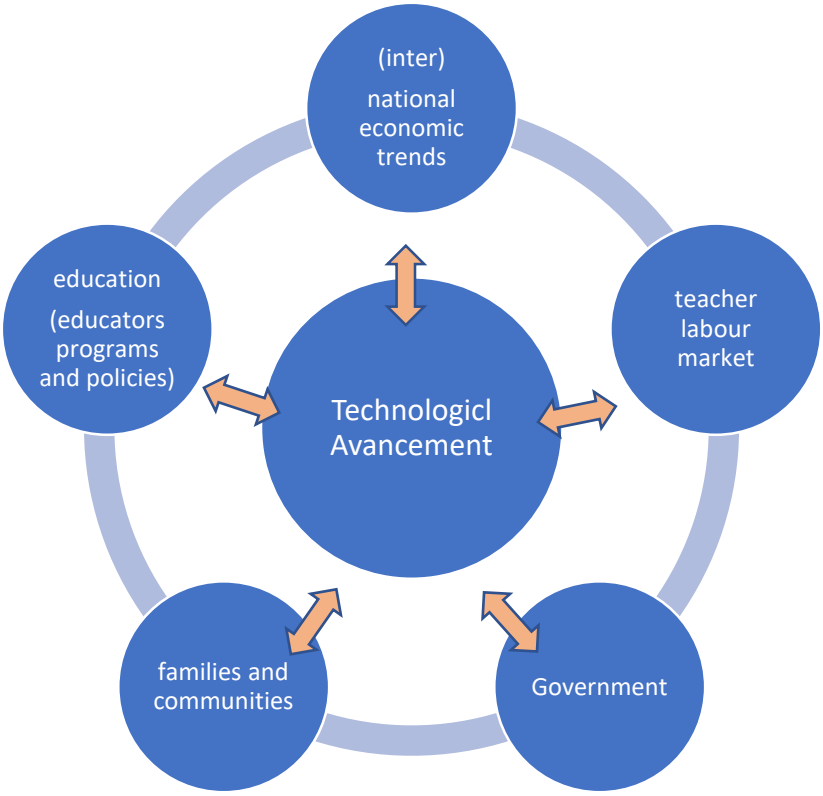
Parsons emphasised the concept of functionalism prerequisites to elaborate the dire need to solve societal problems for societies to continue existing as independent and distinctive entities (Hudson, 1978). Hence, structural functionalists emphasize the need for social stability, which is achieved when social institutions such as the government, law, religion, education and norms work together to meet the needs of the citizens (Adeosun et al., 2022). Therefore, to understand the societal impact of teacher unemployment, the study analysed the impacts of technological advancement and technological unemployment on various sectors of society like family, education, economy, the state and policies as demonstrated in Figures 5 and 6.

The following two subsections below represent the two frameworks on technological unemployment and technological advancement.

2.8.1.1 Technological Advancement

Figure 5, illustrates how Technological advancement directly impacts the five sub-systems in society. As cited earlier, Technological Oligopoly, Outdated Tax systems, skills mismatch, technological change and inadequate tax systems are the causes of dysfunctionality in society. Therefore, the notion of deploying social robots into classrooms is presented as a technological advancement which influences the sub-systems like the employment labour markets; families; economic trends; education programmes and policies; and social deviation, as depicted below.

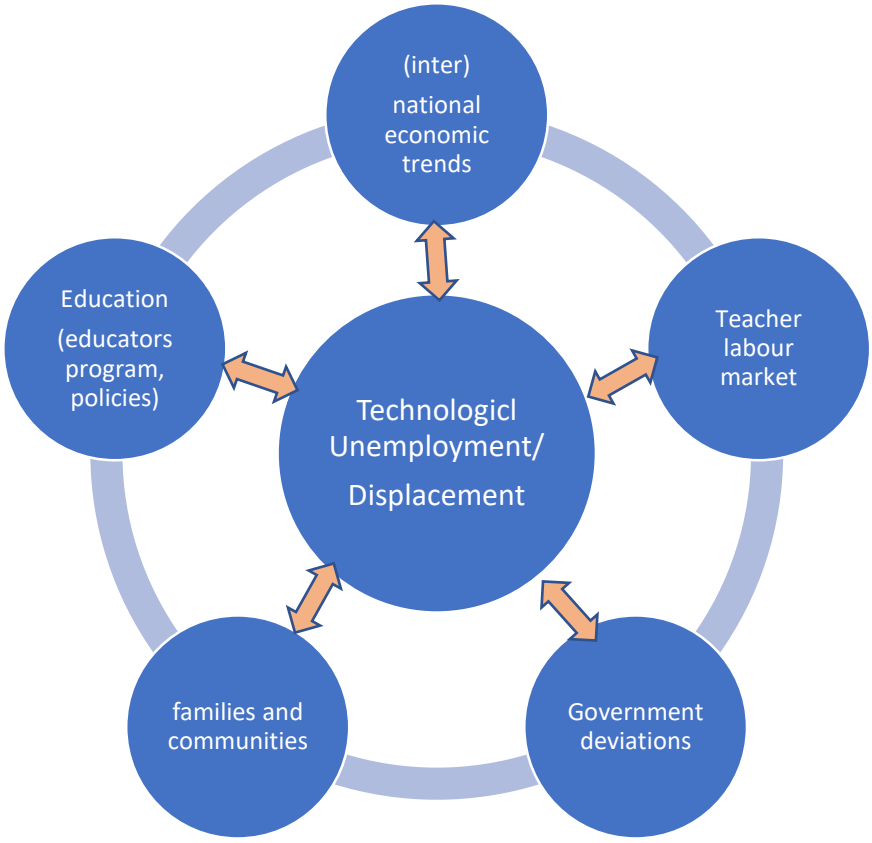
Figure 5: Cause –Technological advancement in society.



2.8.1.2 Technological unemployment

Figure 6, illustrates how the consequences of technological unemployment and displacement directly affect the five sub-systems of the society. According to research, teacher unemployment is a great concern for many developing countries (Bennell, 2023; Mapepa & Adekoye, 2019; Mbokazi, Lebeloane & Mkhasibe, 2023). Therefore, the notion of deploying social robots into classrooms does not only add to pre-existing unemployment rates but it impacts other sub-systems like the employment labour markets; families; economic trends; education programmes and policies; and social deviation, as depicted below.

Figure 6: Consequences –Technological Unemployment and displacement in society.



Limitation

Structural functionalism was widely critiqued and fell out of favour in the 1970s. It was critiqued for being unconnected, abstract and over-generalized (Cornwell & Laumann, 2016). In addition, the most prevalent critiques were focused on structural functionalism failing to recognize social conflict in the sense that the framework overlooked power struggles, inequalities and social change.

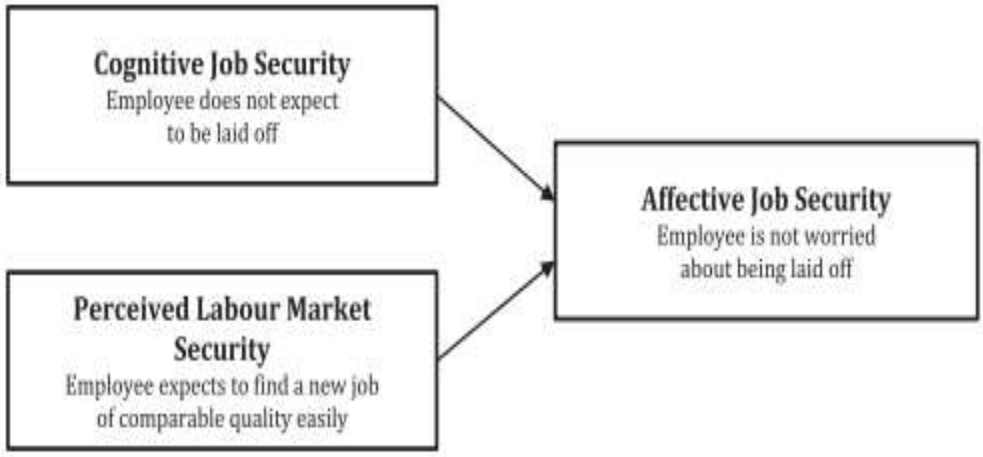
2.8.2 Theoretical models

This second subsection under 2.8 only addresses one main idea on theories that model job insecurity.

2.8.2.1 Job (in)Security

Numerous theories on job security have been created throughout the years to explain the phenomenon. According to Hipp (2019), there are three types of job security facets in the labour market: 1) *Cognitive job security*, this captures the employees' expectation to keep the job on the basis that they know that they are not easily replaced; 2) *perceived labour market security*, this captures the employees' expectation to easily find a new job, on the basis that their skills are of value; and 3) *Affective job security*, this captures the employees' absence of worries regarding job loss. These three facets are related, although they do not overlap each other as depicted below.

Figure 7: Types of Perceived Job Security.



Source adopted: From Hipp (2019).

2.9 Significance of the theory

Relevant to this study, Structural functionalism is a branch of macro-level sociology, a discipline focused on how to understand social relations and social patterns. Macrosociology enables the analysis of large-scale and long-term issues in human society concerned with the state, organisations, society, economy and culture. Amzat and Maigari (2021) denote that a macro-sociological lens does not consider individuals, hence it aligns with a positivistic approach adopted in this study.

2.10 Chapter Summary

In this chapter, this study discussed the following subtopics: conceptualization of the term robots; exploring the concept of unemployment caused by technological advancement and characteristics of automated jobs. Analysed teacher labour market including empirical studies on teacher perceptions of robots. Discussed the theoretical framework which entailed 1) the theory of structural functionalism in the context of technological unemployment and social unrest. And, 2) a theory model outlining the cause of job insecurities.

Drawing from the literature, this study was able to contextualise the aspect of automation within the field of education. According to the reviewed literature, there are a few numbers of studies conducted on job automation impacting teachers' labour market. Nonetheless, most of the reviewed studies explored the possibility of deploying robot teachers or assistants in classrooms and found that engaging robots to teach creates a different learning environment. Irrespective of a variance in teaching strategies, the main goal of teaching and learning was achieved. Furthermore, most studies raised similar concerns regarding the limitations of deploying robots.

In addition, drawing from the three international empirical literature (Alhashmi et al., 2021; Pareto, 2022; Van Ewijk et al., 2020) and one local empirical study (Batchelor & Petersen, 2019), this study concludes that the three international studies made use of an actual robot model, where learners and teachers engaged with the robot. While the local South African study did not.

CHAPTER THREE: DESIGN

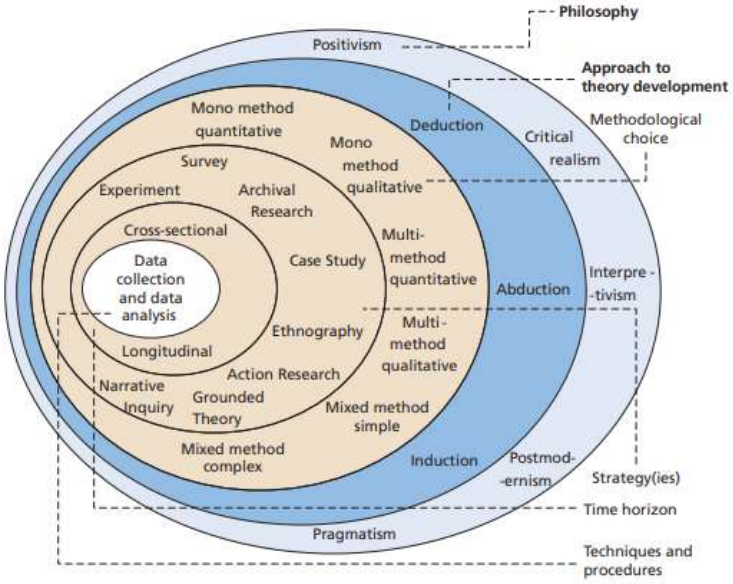
3.1 Introduction

This study aimed to explore teachers' perceptions of unemployment caused by the possibility of deploying robots into the teaching profession in South African schools. Furthermore, it sought to investigate and explore how different factors, primarily the different geographical locations of the school and school rankings (classified as quintiles 1, 4, and 5), influence teachers' perceptions of AI humanoids being deployed to replace or assist teachers. The study attempted to answer the following questions:

1. Are South African teachers concerned about technological unemployment within the teaching profession?
2. What are the differences in teacher perceptions regarding robots replacing or assisting teachers in classrooms in South African schools?
3. How do different teachers perceive the relevance and practicality of robots in enhancing quality education in the future?
4. How do different factors such as school quintile, age, and subject specialization influence the teacher's viewpoint on deploying robots in South African schools?

This chapter is systematically outlined to detail the paradigm; study approach; research methodology; the location of the study; sampling techniques; research instruments and ethical consideration of the study, using a structure adapted from the Research Onion metaphor (see Figure 8).

Figure 8: Research onion.



Source adopted: Saunders, Lewis, & Thornhill (2007).

3.2 Positivist paradigm

The first layer of the research onion (Figure 8) outlines the suitable research paradigm for the study. In this study, the positivist research paradigm guided the research discoveries through principles that informed its design, methodology, and analysis (Park, Konge & Artino, 2018). As the preferred paradigm, positivism is distinguished as a systematic and scientific way to objectively measure and quantify social facts.

Adopting a positivistic paradigm simply implies that this study sought to apply a scientific methodology in understanding humans [teachers] in society. From an epistemological perspective (how the nature of knowledge is conceived), the researcher acknowledged that a positivistic school of thought differentiates the researcher and the world as two separate entities; meaning the world exists regardless of the researcher's presence (Gemma, 2018; Park et al., 2020). From an

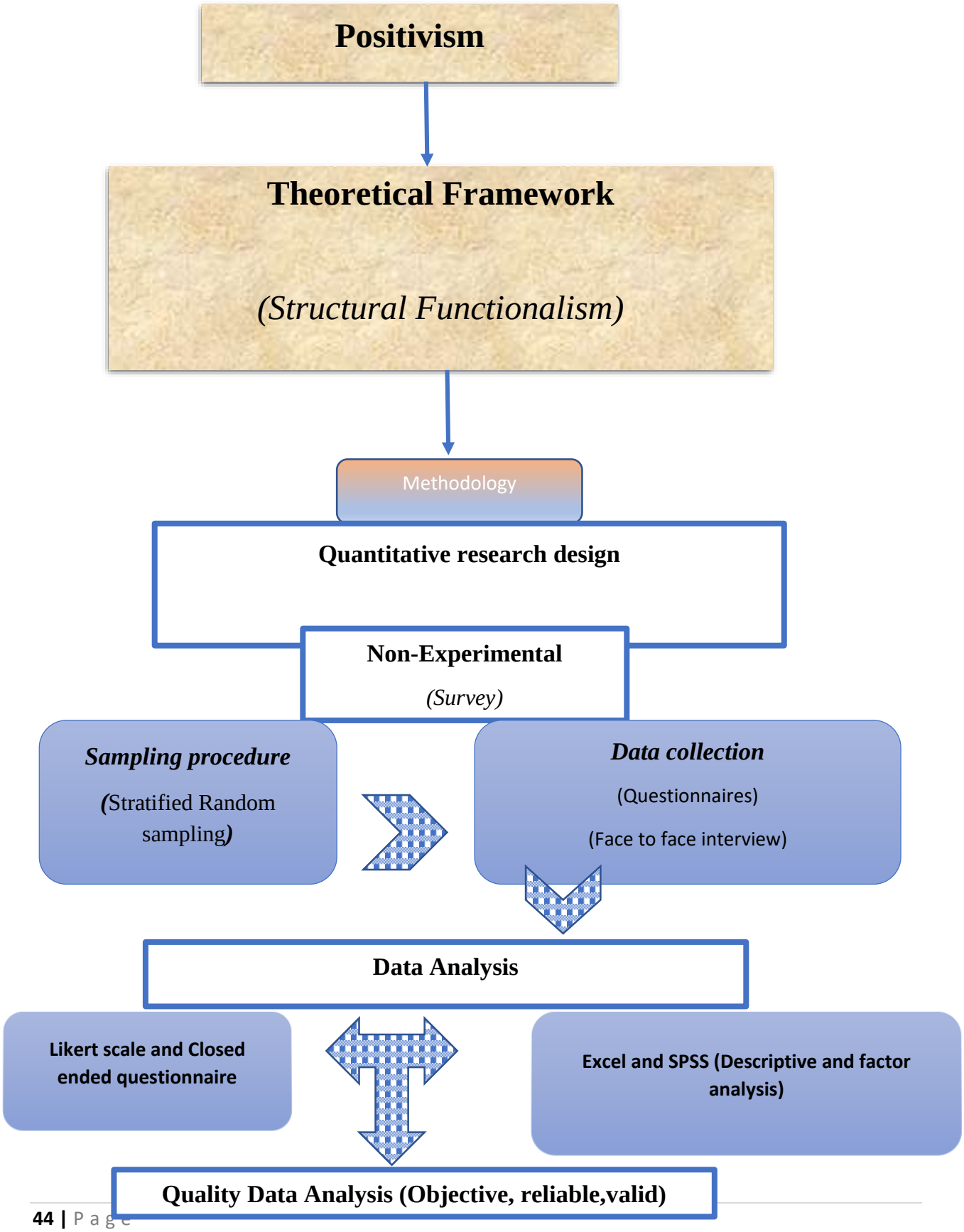
ontological perspective (how reality is viewed), the researcher acknowledged that there is a single tangible reality; one that can be measured and understood through deductive reasoning (Gemma, 2018; Park et al., 2020).

Therefore, a positivistic paradigm was suitable for this study on account that its analytical tool enabled the researcher to comprehend complex phenomena from a macro perspective catering to generalizable inferences and replication of reliable findings (Blackwell, 2018). This implies that the findings about the sampled teachers from the three schools selected to participate in this study can be generalised, to some extent, to the broader population of teachers across South Africa.

3.3 Research Methodology

This study adopted a quantitative research approach. The nature and purpose of quantitative research are outlined by Adedoyin (2020) as an organized inquiry about a phenomenon through a collection of numerical statistical or computational techniques. One of the affordances of utilizing a quantitative study is that it allows the researcher to match the research design with the aims and objectives of the study, which are to gain a generalised knowledge and understanding regarding how a sample of 45 teachers from different schools differ in perception regarding the notion of technological unemployment. In addition, a quantitative research approach enabled this study to use statistical data, as a tool to save time and resources.

Figure 9: Research Model.



Source adopted: from (Blessed-Sayah, 2020)

3.4 Research design

The third layer of the research onion demonstrates the researcher's tentative plan to address the research questions and Figure 9 outlines the methodology process in a model. According to Creswell and Creswell's (2017) study an experimental, longitudinal or a non-experimental research designs are suitable for a quantitative study. An experimental research design enables a researcher to investigate how one or more dependent variables are manipulated to measure the effect it has on one or more variables (Asenahabi, 2019). It is highly recommended when a study aims to analyse cause-and-effect relationships on a subject matter. Alternatively, a longitudinal research design enables an analysis of the cause-and-effect theory over an extended time period.

However, an experimental and longitudinal research design does not align with the aims and objectives of this study. Therefore, a non-experimental research design in the form of surveys was preferred on the basis that a survey methodology allowed the researcher to collect numeric descriptions of trends, attitudes and beliefs of different teachers by studying the sample of the teacher population (Creswell & Creswell, 2017; Asenahabi, 2019). The use of surveys further enabled the researcher to effectively gather large amounts of data in a short period through closed-ended questions.

Creswell and Creswell (2017), and Asenahabi (2019) attest that the time horizon of a research study conducted through a survey can be classified as cross-sectional or longitudinal. Cross-sectional means that data is collected at one or more *points in time* while longitudinal studies collect data repeatedly at *different points in time*. Thus, due to the nature of this study, data was collected at a specific period mapping a cross-sectional study.

3.5 Location of the Study

Figure 10: Tshwane district.

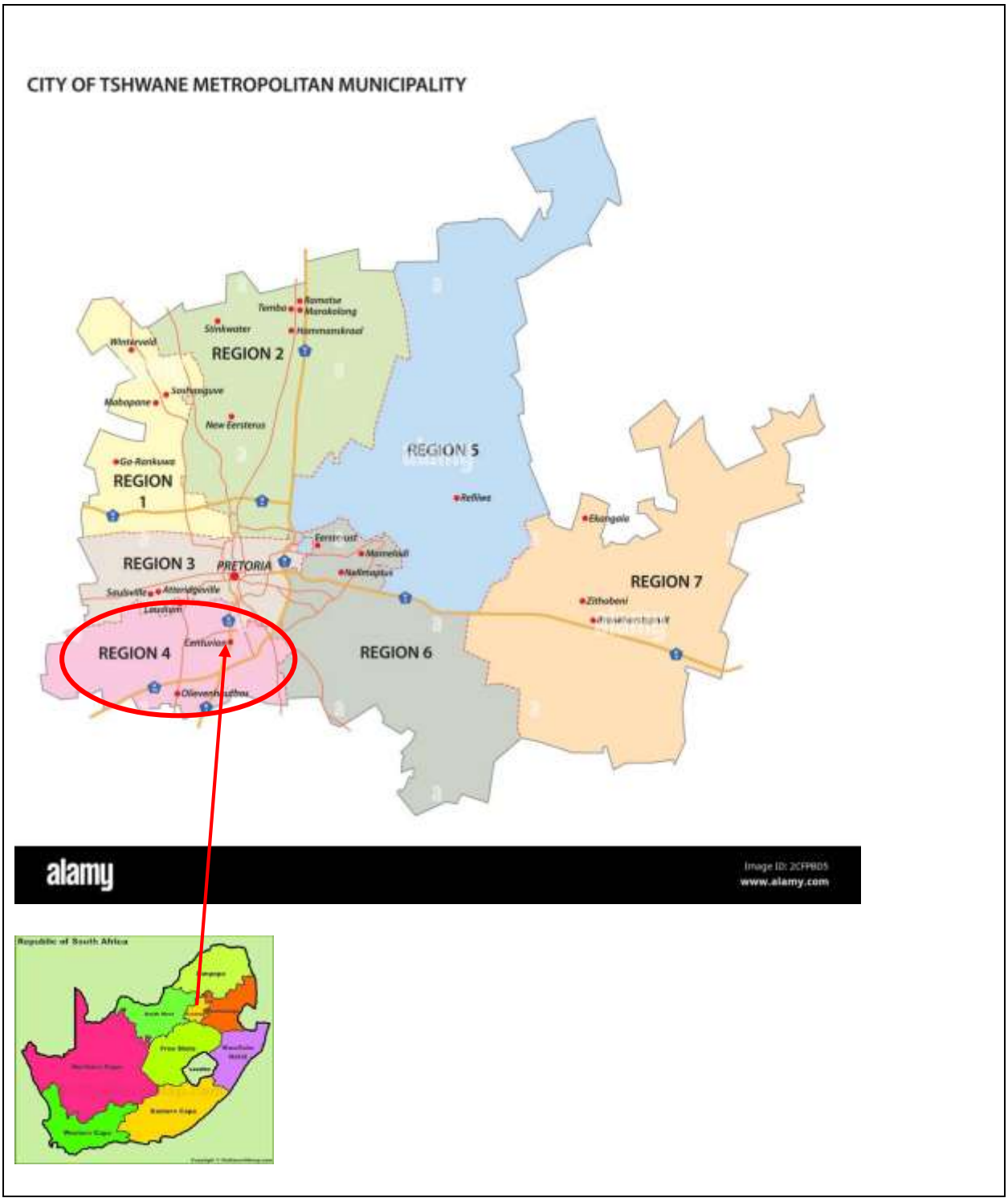


Table 4: Tshwane South District NSC School Performance.

School	Quintile	2020	2021	2022	2023
School 1	1	92.4%	89.1%	89.5%	80.5%
School 2	4	97.0%	86.1%	86.8%	88.5%
School 3	5	95.7%	93.1%	96.5%	97.7%

Sources adopted from: School Performance Report (DBE, 2023).

This study was conducted in three public schools namely, School 1, School 2 and School 3 located in the city of Tshwane Metropolitan Municipality, Centurion (as depicted in Figure 10). These aforementioned schools were selected because firstly, Shepherd (2022b), attests that about 92 % of teachers in South Africa are employed in the public sector. Therefore, the public schools selected sought to represent the larger population of teachers.

Secondly, all the schools selected obtained a Senior Certificate Examination (SCE) pass rate above 80% from 2020 to 2023 (as depicted in Table 4, (DBE, [2023]). However, they differ in quintile ranking. Van Dyk and White (2019), asserts that school ranking is based on the unemployment rate and literacy rate of the community in which the school is located; with quintile 1 schools indicating poor/impoverished schools while quintile 5 indicates wealthy/affluent schools. According to the South African Schools Act 84, section 2 (1996), School 1 School is ranked as quintile 1 because it caters for the poorest 20% of learners in the province and is a non-fee-paying school; School 2 is ranked quintile 4 because it caters for the least poor 40% of learners and is a fee-paying school; and School 3 is ranked quintile 5 because the school caters for the least poor 20% of learners and classifies as a fee-paying school.

Therefore, it was expected that even though all three schools were classified as functional and performing schools, the difference in rankings portrayed existing inequalities and prehistorical social ills. Hence, the specified site was purposefully selected to cover different cultural, geographical and socio-economic factors that may influence different teacher's perceptions.

3.6 Data Collection

The researcher obtained permission from the Gauteng Department of Education (Appendix A) and the University of Witwatersrand School of Education (WSoE) Ethics Committee (Appendix B) to conduct a quantitative study in three public schools located in the Tshwane region. The researcher was also granted permission by the school principals to conduct research in their schools (Appendix C). Teachers were given an information sheet (Appendix D) detailing the background and objectives of the study. In addition, teachers were given a consent form (Appendix E), acknowledging that they were willingly participating in the study. Upon their approval to participate, teachers were given a questionnaire (Appendix F).

Of the 45 respondents that participated, the researcher further collected additional data using quantitative interviews. The 4 respondents who participated in the interview were given an information sheet (Appendix G) detailing the procedures associated with a structured face-to-face interview. Lastly, when respondents agreed to partake in the interview session, they answered structured questions (Appendix H).

Utilising Taherdoost's (2016) stages of sampling method, the next section will define the target population; selected sampling frame; choice of sampling technique, determine the size; collected data; and assess the response as seen below.

3.6.1 Respondents

To make inferences about the teacher population, the researcher selected a sample that maximizes the true reflection of the greater population of teachers using Taherdoost's (2016) prescribed sampling process. The teacher robot is a concept meant to take over teaching responsibilities, therefore the population that is impacted by this, is teachers. As a result, in line with the aims and objectives of this study (investigating different teacher's perspectives on robots), the researcher selected teachers from public schools as the target population. The researcher excluded private school teachers because most teachers in South Africa teach in public schools; and, they have a

contextual variety of socio-economic representation in the form of quintile rankings (Shepherd, 2022b).

3.6.2 Sampling strategy

Sampling is described as a phenomenon of selecting a subset from a population and according to Taherdoost (2016), sampling can be divided into two categories, probability sampling (random) and non-probability sampling (non-random). Probability sampling means that every item in the population has an equal chance to be included in the sample, while non-probability sampling entails selecting respondents with no specified requirements. Taherdoost (2016) highlights that non-probability sampling methods are best suitable for qualitative studies, therefore for this quantitative study, the latter was used. Amongst the handful types of probability sampling methods, this study utilised a Stratified Random sampling technique. This method was selected on the notion that it allowed the researcher to categorise schools by relevant desirable characteristics (Quintile and the geographical location of the school). In this study, 45 teachers were selected and the ratio was targeted to be 15 teachers per school. However, due to time constraints and teacher unavailability, the researcher gathered the following ratios per school: School 3 (n=16), School 2 (n=13) and School 1 (n=16).

3.6.3 Research Instruments

This section details the type of instruments used to collect data in this study. As outlined, there are two subsections below detailing firstly the use of a questionnaire with a Likert scale and secondly face-to-face interviews.

3.6.3.1 Surveys and Questionnaires

A questionnaire is based on a set of questions used to gather data from respondents and is regarded as the most dominant way of collecting primary and quantitative data (Taherdoost, 2022). Questionnaires are widely used in educational research because questionnaires enable the researcher to reach a sizable and potentially varied group of people fairly quickly Holmes (2023). Thus, it can ensure a faster and more accurate data collection process (Young, 2015).

Using a cross-sectional design, the surveys enabled the study to gather data and scope of how teachers perceived technological unemployment at that particular time when the survey was administered. Taherdoost (2022) and Acharya (2010) argue that there are mainly two types of questionnaires: structured and unstructured. Structured questionnaires include pre-coded questions and a well-defined sequence of questions are advised to use in a quantitative study. An unstructured questionnaire includes open-ended and vague opinion types of questions. As mentioned above, a structured questionnaire was preferred on the account that it allowed the researcher to collect the respondents' responses systematically in a standardized format (consistent answers).

Lastly, the 15 questions administered through a structured questionnaire were drafted to gather respondent's perceptions using a Likert scale measurement. A Likert scale refers a summative scaling type that arranges the opinions in a specific range from extremely positive to extremely negative (Taherdoost, 2022). The researcher administered and gathered the questionnaires in three days of which one day was spent in each school.

3.6.3.2 Face-to-face Quantitative Interviews

Post the administration of questionnaires, the researcher identified responses that were outliers. Out of the 45 teachers, the researcher identified 7 teachers who had intriguing responses. However, due to availability and time constraints, only 4 teachers availed themselves for the interview. Therefore, based on those outliers, the researcher drafted a follow-up structured questionnaire as a way to gather insight from the respondent's responses through a quantitative interview.

Face-to-face interviews are still the most preferred means of collecting primary information, compared to telephonically or non-contact interviews even though they are time-consuming and

costly. Interview-guided surveys yield maximized quality data and measurable reliability in contrast to non-interview surveys (Neuman, 2012). Hence, the follow-up session was through a face-to-face interview with the teacher.

During the quantitative interview, information was obtained by asking closed-ended questions and providing categorized responses for the respondents to choose from. While the researcher was recording, the questions and responses were communicated through a verbal dialogue between the researcher and the teacher. In quantitative studies, interviews are also used just like it has been used in qualitative studies, the difference is in the former they are standardized and not much variability is allowed.

3.8 Data analysis

Data was interpreted and analysed quantitatively using Excel and SPSS software v.26. The study utilised descriptive statistical analysis to count and generate percentages to summarise categorical data. In addition, using SPSS, the study generated the mean and standard deviation of the Likert scale per question which was interpreted using a weighted mean scale adopted from Pimentel (2010). To assess the reliability and validity of the research questionnaire, the researcher utilised a Cronbach's Alpha as suggested by Sürücü and Maslakci (2020) to measure the items using SPSS to ensure that the research tool had a Cronbach's Alpha within an acceptable threshold. Obtaining a Cronbach's Alpha value above the acceptable threshold means that the questionnaire measured the desired construct and, thus is considered valid and reliable.

3.9 Ethical consideration

To effectively conduct this research study free from harm and not endanger human respondents, Cacciattolo (2015) emphasized that researchers should shy away from unethical acts such as deception and violation of privacy and confidentiality policies. For that reason, the researcher at maximum effort adhered to all ethical obligations by refraining from violating any respondents

human rights and formulating questions that did not probe or condone any form of discrimination or deception by influencing the participant to provide the desired answer. The questionnaires were analysed by the WSoE Ethics Committee before receiving a certificate of clearance (Appendix B). Lastly, the names of the schools were kept confidential, by using pseudonyms to reference each school as school 1(Quintile 1), school 2 (Quintile 4), and school 3 (Quintile 5).

3.10 Ways to Deal with Biasness

The quest to address the study's bias stems from the notion that bias impacts the study's validity and reliability, which impacts the findings and data interpretation (Smith & Noble, 2014). In this study, bias is defined as prejudice or an inclination for or against an individual or group. In the context of research, Smith and Noble (2014) suggested several types of biases mainly being design, participant selection, data collection and data analysis biases. To limit these suggested biases, the study addressed each factor as seen below.

Selection/participant bias

In a quantitative study, the sample must resemble the actual population to generalise findings. On that account, the schools were thoroughly selected with the objective that they would represent the large teacher population as mentioned in section 3.5.

Data collection biases

Data was collected through two different instruments at two different periods.

Analysis bias

The study utilised two data analysis methods and applications to ensure similarity between the data. The researcher first analysed the data using descriptive methods through Excel and then further generated a Mean summary for the Likert-scale using SPSS v.26 ensuring that the analysis yielded similar results. Lastly, Cronbach's alpha was calculated to determine the item construct

and consistency. An acceptable value above the accepted threshold was achieved for the questionnaire proving the reliability and validity of the instrument that was analysed.

3.11 Chapter Summary

This chapter outlined crucial aspects detailing how the research was conducted by providing a blueprint for the study. The main themes addressed in the research design were the study's paradigm; study approach; research methodology; the location of the study; sampling techniques; research instruments and ethical consideration of the study, using a structure adapted from the Research Onion metaphor.

CHAPTER FOUR: FINDINGS

4.1 Introduction

In this chapter, I present the data analysis and provide the interpretations of the results on how teachers from South African secondary schools perceive unemployment caused by technological advancement in their field. The collected quantitative data was analysed and presented using frequency tables, figures, graphs and texts. First to be analysed and presented is the questionnaire return rate for the respondents, followed by the respondents' demographics. Thereafter, the findings are presented in line with the investigation of different teachers' perceptions of the relevance of a teaching job *(Theme 1);* the different teachers' perceptions regarding robot teachers *(Theme 2);* the practicality of deploying robots *(Theme 3);* and the factors that may influence teachers' perceptions on robot teachers *(Theme 4),* which are the objectives of the study.

4.2 Return Rate

The frequency Table below presents the analysis of the return rate for the respondents who participated in the study and completed the questionnaire provided by the researcher.

Table 5: Questionnaire Return Rate.

	Respondents			
	Targeted		**Returned**	
	Frequency	**%**	**Frequency**	**%**
School 1	15	33.3%	16	35.6%
School 2	15	33.3%	13	28.9%
School 3	15	33.3%	16	35.6%
Total	**45**	**100.0%**	**45**	**100.0%**

Table 5 presents the difference between the targeted respondent rate in comparison to the actual respondent rate acquired in the period of the study. When the study was conducted, the researcher targeted 15 respondents per school, however when the researcher went to each school, there was a surplus of 5 questionnaires in case more teachers wished to participate in the study. Thus, even though the researcher aimed to receive 15 returned questionnaires from School 1, instead, 16 teachers participated in the study, which shows an increment of 1 respondent as compared to the intended target. Similarly, in School 3 about 16 teachers participated in the study, projecting an increment of 1 respondent as compared to the intended target. However, School 2 had fewer respondents in comparison to schools 1 & 3 and it did not meet the intended target, resulting in 13 return rate respondents. This was due to teacher unavailability and lack of interest to participate in the study. Nonetheless, the total number of teachers who participated still amounted to 45 respondents, which did not compromise the results of the study.

4.3 Descriptive Analysis of the Demographic Information

This part of the study provides a summary of the respondents biographical information that was classified as relevant to the study. This section utilizes frequency Tables followed by a graph to present the respondents' Gender, Age, Experience and Subject specialization.

4.3.1 Gender of the Respondents

Table 6: Gender Distribution.

Gender		
	Frequency	**%**
Female	26	57.78%
Male	19	42.22%
Total	**45**	**100%**

Figure: 11 Gender Distribution.

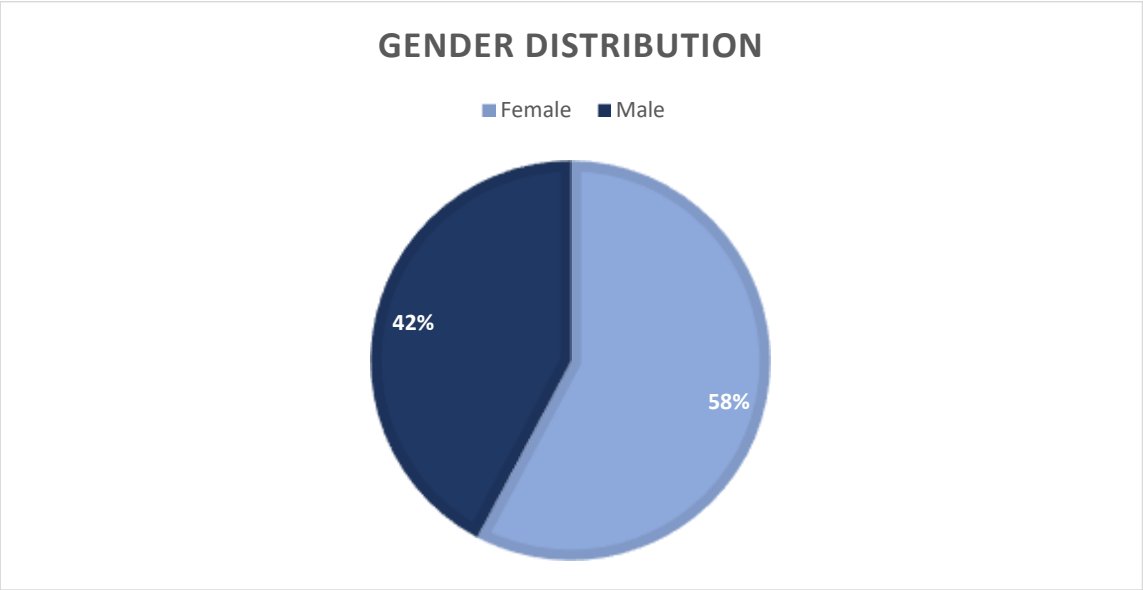


Table 6, presents a frequency Table on the gender distribution of respondents across all three schools. The majority of the respondents were female representing 58%, while the males represented 42%. Similarly, to the information presented in Table 6, the Pie Chart displayed in Figure 11 also provides the same information on gender except it provides a pictorial representation and an overall graphical shape of the data, which is easier to analyse.

The fact that female respondents were the majority, shows that there are more female teachers employed in schools than males. Research shows that male teachers are outnumbered by female teachers across primary and secondary schools in South Africa (Davids & Waghid, 2020; Shepherd, 2022b). Amongst other reasons, existing literature indicates that teaching is usually not the first option for males and historically there are concerns regarding the ethics of care towards students (Davids & Waghid, 2020). Hence it is not surprising to note that the study's findings reflect that the teaching career is highly feminized.

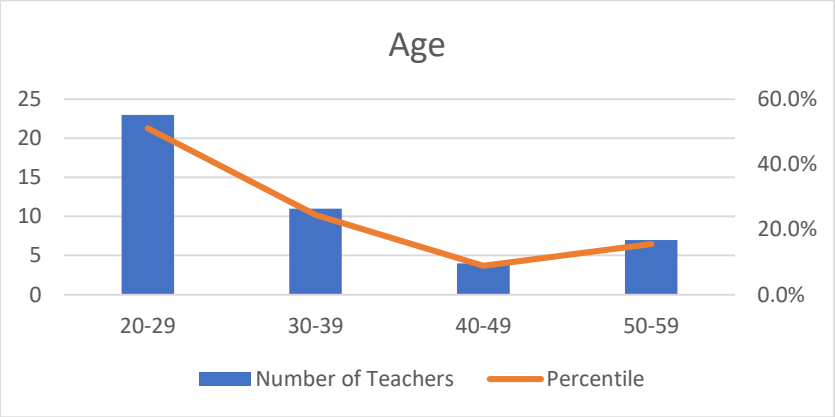
4.3.2 Teacher Age Distribution

Table 7: Age Distribution.

Age			
	Frequency (f)	**Midpoint (m)**	**[f . m]**
20-29	23	24.5	563.5
30-39	11	34.5	379.5
40-49	4	44.5	178
50-59	7	54.5	381.5
Total	45	158	1502.5

Mean = $\frac{\sum[f.m]}{\sum[f]} = \frac{1502.5}{45} = 33.38$

Figure: 12 Age Distribution.



According to Table 7, the age mean value for the respondents amounts to approximately 33 years, which demonstrates the measure of central tendency of the data set. Additionally, Figure 12, shows that the age distribution of the respondents is skewed to the left which entails that the majority of the teachers in this study were between 20 and 29 years. Furthermore, Figure 12 shows that about

half of the teachers that took part in this study were between (20 – 29) years, which amounts to a percentile of 51% followed by the age group between (30 – 39) years amounting to 24%.

Regarding teachers aged between (40 – 49) years, they were the least amounting to 8.9% which is almost half of those aged between (50 – 59) years. Surprisingly, Simkins (2015) disclosed that South African teachers aged between (40 – 49)[1] Years outnumbered other age groups in the teaching field amounting to approximately 43% (n=169 012 out of 390 164), while those aged below 29 amounted to 8 % (n=31 383 out of 390 164). Similarly, the Socio-Economic Policy Report Research showed the peak age distribution of teachers shifted from the age group between (40 – 45) years in 2011 to a peak of (50 – 55) in 2021 (RESEP, 2022).

4.3.3 Teaching Experience Distribution

Table 8: Experience Distribution.

Teaching Experience		
	Frequency	**%**
1 - 10 years	34	75.6%
11- 20 years	3	6.7%
21 - 30 years	4	8.9%
31- 40 years	4	8.9%
Total	45	100.0%

[1] Findings were drawn from a database of registered South African teachers with a Persal number.

Figure 13: Experience Distribution.

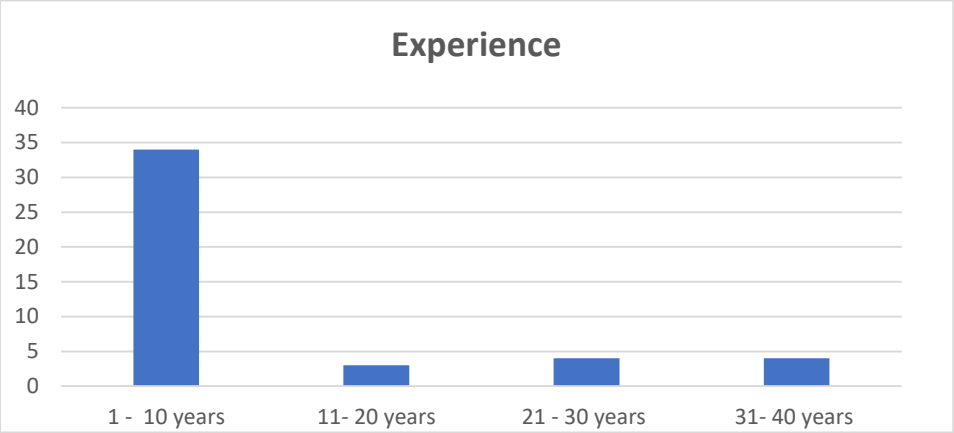
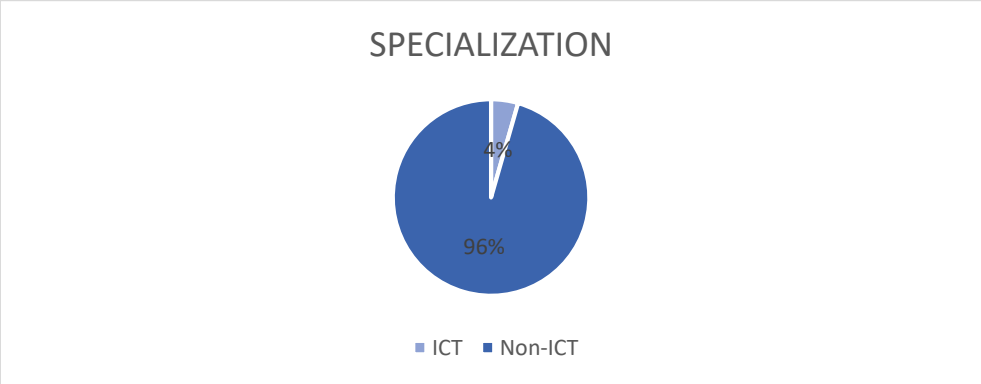


Table 8 shows that the majority of teachers have teaching experience of less than 10 years amounting to 75.6 % of the study population. Fewer teachers have teaching experience above 11 years, meaning that fewer teachers have accumulated more knowledge, skills and insights in their teaching career over a long period. Figure 13 shows similar information using a graphical representation.

4.3.4 Subject Specialization

Figure 14: Specialization.



As seen in Figure 14, the majority of the teachers (96%) did not specialize in subjects related to Information and Communication Technology (ICT), which is aligned with concepts about

computers, software, AI, robotics, machines etc. Only 4% of teachers taught Computer Application Technology (CAT); a subset of ICT that focuses on using computer applications to solve practical problems.

4.4 Teacher perceptions about technological advancement, technological unemployment and job insecurity.

This section presents the results of the survey administered to the 45 teachers. To analyse the different teacher perspectives, the questionnaire was divided into three main subtopics job insecurity, technological advancement and technological unemployment. The scoring patterns of questions 1 to 15 are summarized in the tables and graphs below. The levels of disagreement (strongly disagree and disagree) were combined to form an overall classification of disagreement. A similar technique was applied to the levels of agreements.

Theme 1: The relevance of a teaching career in the future

4.4.1 Teachers' Perception of Job Insecurity

Figure 15: Teacher trends on job insecurity.

(Note* Q1, Q2, Q3 refer to Question 1, Question 2 and Question 3)

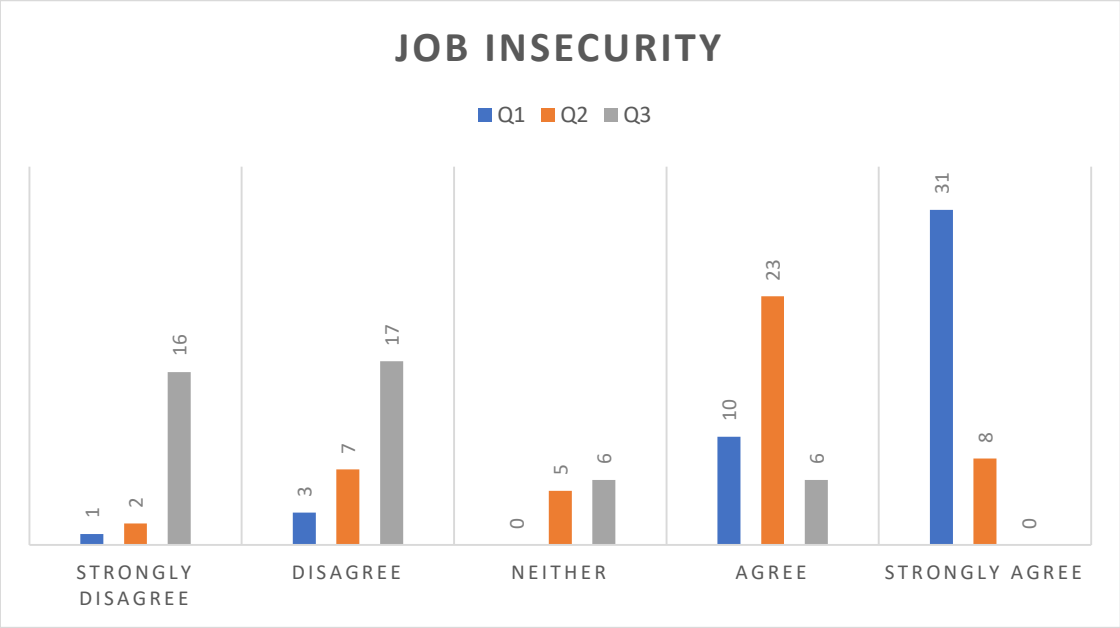


Table 9: Job insecurity.

No.	Question	Answers	SD	D	TOTAL DISAGREEMENT	Neither	A	SA	TOTAL AGREEMENT	OVERALL
Q1	A Teacher job will be relevant in 20 years from now?	frequency	1	3	4	0	10	31	41	45
		percentage	2%	7%	9%	0%	22%	69%	91%	100%
Q2	Finding a teaching job in the future will be hard and rare.	frequency	2	7	9	5	23	8	31	45
		percentage	4%	16%	20%	11%	51%	18%	69%	100%
Q3	Employing robot technology as a teacher is practically possible in South African schools.	frequency	16	17	33	6	6	0	6	45
		percentage	36%	38%	73%	13%	13%	0%	13%	100%

Figure 15 and Table 9 present a summary of the findings on how the respondents perceive job insecurity in the teaching field. Drawing from Q1, it can be deduced that the majority of teachers (91%) believe that a teaching job will still be relevant in 20 years irrespective of the instantaneous change in technology. The aforementioned statement is justified by the fact that research shows that from the mid-1980s recession period, teaching has always been regarded as one of the most secure occupations (Rosenblatt & Ruvio, 1996).

Moreover, Q2 reveals that most teachers (69%) acknowledge the fact that, while a teaching profession is essentially relevant in the context of education and imparting knowledge to students, finding a teaching vacancy will be hard and rare in the future, indicating a presence of job insecurity. However, Q3 further reveals that the teacher's job insecurities do not stem from total replacement by robot machines because most teachers (73%) in Q3 highlighted that, it is not practically possible to employ a robot teacher in South African schools.

Notably, the reason why 69% of teachers feel anxious and concerned about finding a teaching job in the future here in South Africa, is best addressed by Mbokazi et al. (2023). Mbokazi et al. (2023) stipulate that the increase in teacher unemployment is a direct consequence of increased university enrolments to pursue teaching through B.Ed. or PGCE; the limited number of available teaching posts; and lastly, the increased number of immigrant teachers filling in posts.

About 73% of teachers who object to the practicality of integrating robot teachers in a South African context exhibit characteristics aligned with *Cognitive job security* (Hipp, 2020). This implies that the teachers are aware that they are not easily replaced, therefore they are not job insecure when it comes to automation. Yet, 13 % of teachers think employing robots is practically possible; portraying characteristics of job insecurity triggered by automation (Luco et al., 2019).

The study further explored that some teachers (9%) are concerned that the teaching job might not be relevant in the next 20 years. To establish the motive behind these findings, the researcher administered face-to-face structured interviews with four teachers whose responses were similar for Q1, Q2, Q3, Q13 and Q14. The motives behind their pessimistic perceptions for Q1, Q2 and Q3 are discussed and summarised in the Table below (*Note, Q13 and 14 are analysed in theme 2 for correspondence).

Table 10: Job Relevance.

A teacher's job will not be relevant 20 years from now due to robots.		
Response	**Frequency**	**%**
1. Robots will be able to do everything that a teacher does in class.	0	0%
2. The government will opt for robots instead of teaching human beings who keep striking and staying away from work.	1	25%
3. Learners will demand to be taught by robots instead of human beings due to global influence and techno-surveys.	2	50%
4. I am just fearful even though I do not have a good reason to say so.	1	25%
Total	4	100%

Firstly, the education environment is regulated by National and Provincial policies through various stakeholders such as the Government, Non-Government Organisations (NGOs), school governing boards and others. However, global change in politics, society and culture also has a direct influence on educational policies, practices and educational institutions (Moloi, Gravett & Petersen, 2009). Similarly, the quest to remain globally relevant informs educational policies. To illustrate, the Gauteng Department of Education (GDE) piloted the paperless classroom project in 2015 as a way to embrace and maximise the benefits of integrating technology into the education system (Motebele, 2020), so that it creates a platform to develop digitally literate citizens with relevant skills for the future. Therefore, it is not surprising to note that some teachers (50%) as shown in Table 10, feel that the learner's quest to remain globally relevant may threaten the relevance of their jobs in the future.

Secondly, according to the legislative framework, The Bill of Rights, section 23(1) and section 23(2) outlines that workers have the right to a fair practice and the right to strike. However, the challenge with continuous prolonged teacher strikes is that it affects student achievement (Wills, 2014). Furthermore, research indicates that "in the domestic context, teachers also have engaged

in high levels of strike activity when compared with other sectors. Between 1995 and 2009, SADTU was responsible for 42 per cent of total worker days lost in South Africa over the fourteen years" (Wills, 2014, pp. 6). Hence, it is significant to find that 1 teacher (25%) as shown in Table 11 below, believes that the Government may opt for robots instead of human teachers as a way to address the concerns regarding teacher strikes.

Table 11: Teaching job.

Finding a teaching job in the future will be hard and rare.		
Response	**Frequency**	**%**
1. The advancement of robots and artificial intelligence will create a new learning platform replacing traditional teachers and their teaching methods.	4	100%
2. The government will opt to deploy robots as a way to save costs and in response to globalisation (4IR).	0	0%
3. The teaching role will cease to exist and a new role will emerge in response to technology	0	0%
4. Other motives that are not caused by the advancement of technology.	0	0%
Total	4	100%

In response to finding a teaching job in the future (Q2), upon the given options, all four teachers (100%) justified that it will be hard and rare to find a teaching job mainly because the advancement of robots and artificial intelligence will create a new learning platform which will replace traditional teachers and their teaching methods. These findings highlight that all four teachers exhibit job insecurities due to the possibility of job automation.

Table 12: Automation and practicality.

Employing a robot as a teacher is **NOT** practically possible in South African schools.		
Response	**Frequency**	**%**
1. Economic constraints, poor infrastructure and lack of resources.	2	50%
2. Diversity, robots cannot interact and they cannot cater for different learner needs.	0	0%
3. Inequalities, the South African education system is characterised by high socio-economic inequalities, hindering access.	2	50%
4. I am just fearful even though I do not have a good reason to say so.	0	0%
Total	4	100%

Unlike Q1 and Q2, Q3 was directed to the current context and not the future. In response to Q3, the interviewed teachers agreed that currently employing robot technology as a teacher was not practically possible in South African schools because of:

- Economic constraints, poor infrastructure and lack of resources.
- Inequalities, the South African education system is characterized by high socio-economic inequalities, hindering access.

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Theme 2: The practicality of deploying robots in South Africa

4.4.2 Teacher's perception on technological advancement

Figure 16: Teacher trends on Technological advancement.

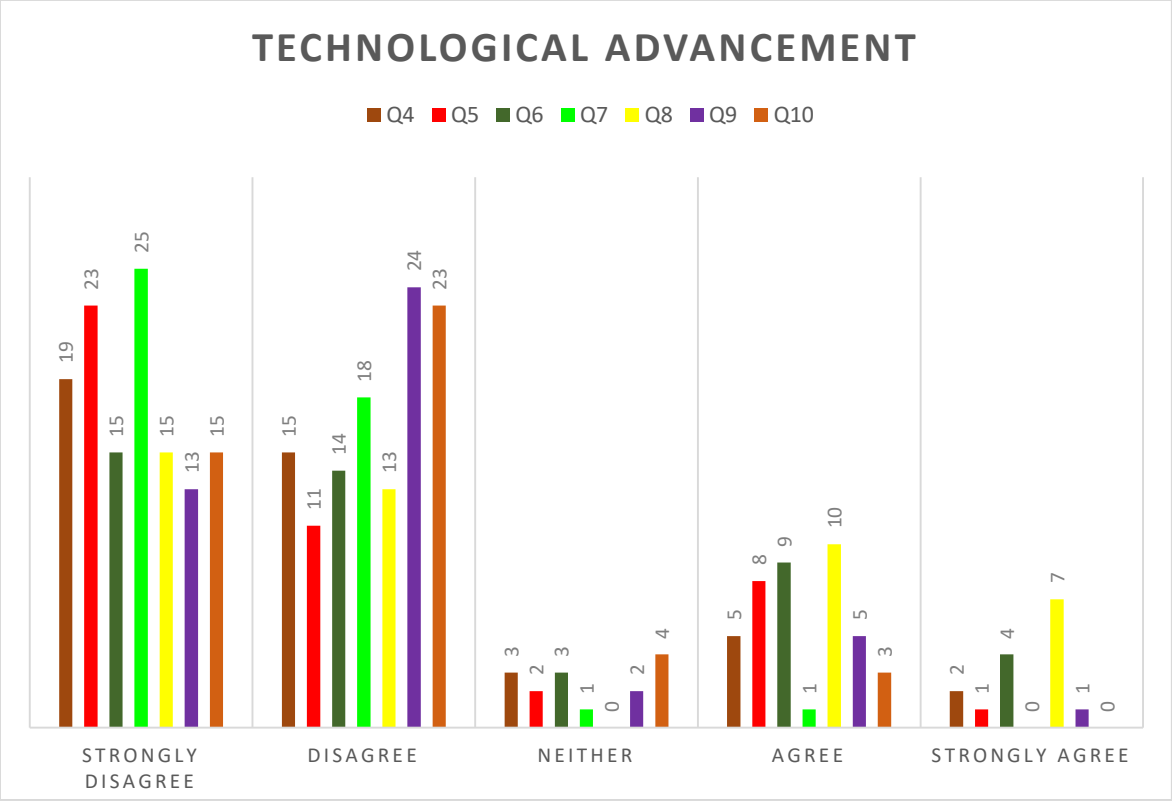


Table 13: Technological Advancement.

No.	QUESTION	ANSWERS	SD	D	TOTAL DISAGREEMENT	Neither	A	SA	TOTAL AGREEMENT	OVERALL
Q4	Robot teachers can adapt to different school contexts, to effectively cater to different learners' needs.	frequency	20	15	35	3	5	2	7	45
		percentage	44%	33%	78%	7%	11%	4%	16%	100%
Q5	Robot teachers can be equipped with substantial abilities to cater to learners' emotional and physical well-being.	frequency	23	11	34	2	8	1	9	45
		percentage	51%	24%	76%	4%	18%	2%	20%	100%

Q6	Robot teachers can mark learners' assessments, tests, and exams much more effectively than human teachers.	frequency	15	14	29	3	9	4	13	45
		percentage	33%	31%	64%	7%	20%	9%	29%	100%
Q7	A robot teacher is capable of maintaining discipline and managing classroom behaviour much more effectively than a human teacher.	frequency	25	18	43	1	1	0	1	45
		percentage	56%	40%	96%	2%	2%	0%	2%	100%

Q8	Robot teachers can address the challenges of language barriers in South African schools since they can be programmed to speak multiple languages.	frequency	15	13	28	0	10	7	17	45
		percentage	33%	29%	62%	0%	22%	16%	38%	100%
Q9	As an experienced teacher, would you trust a robot to effectively perform all the tasks assigned to it as a teacher?	frequency	13	24	37	2	5	1	6	45
		percentage	29%	53%	82%	4%	11%	2%	13%	100%

Q10	Robot teachers can increase security and minimize violence in classrooms.	frequency	15	23	38	3	4	0	4	45
		percentage	33%	51%	84%	7%	9%	0%	9%	100%

Figure 16 and Table 13 present a summary of the findings regarding how the respondents perceive technological advancement in the teaching field. Amongst other reasons such as technological advancement and job effectiveness, scholars such as Edwards and Cheok (2018) justified the need to replace human teachers with robots as a way to address teacher shortage. Therefore, to assess whether robots could replace teachers, the study analysed the role of a teacher in the classroom, the values they impart to their students and how technology promotes teaching and learning – as seen in Q4 to Q10 (Orhani, 2023).

During the analysis of Q4, the study found that most teachers (78%) do not believe that robot teachers can adapt to different school contexts to effectively cater for different learners' needs. Catering for different learners' needs entails modifying teaching methods, materials and lesson plans to match different learners' talents and learning preferences (Orhani, 2023). According to research, Alam (2021) stipulates that the robot's system possesses machine learning and adaptability features which enable the robot to tailor curriculum and material, matching each student's needs. However, this study found that most teachers do not believe that robots can cater for student's needs. Therefore, this implies that most teachers believe that humans are the only entities capable of providing emotional support and well-being to students as suggested by Batchelor and Petersen (2019).

In line with social interaction in classrooms, Q5 shows that a vast number of teachers (76%) believe that robot teachers cannot be equipped with substantial abilities to cater for learners' emotional and physical needs. This corresponds with Orhani's (2023) argument, which suggests that even though robots are built to interact and socialize with humans, the essence of providing socio-emotional support is only rendered by a human touch. Hence, several scholars (Alhashmi et al., 2021; Ekström and Pareto, 2022; Van Ewijk et al., 2020) mentioned that one of the major limitations of deploying a robot teacher is the lack of psychological welfare and emotional intelligence.

Regarding assessment, research shows that teachers do not solely rely on printed materials and textbooks as their source of information (Motebele, 2020). Thus, integrating technology into education has also influenced how teachers teach and assess learners through online platforms like Kahoot, blackboard and Google Forms; which grade tests using artificial intelligence and machine

learning systems. However, when teachers were asked whether they trusted robot teachers to effectively mark learners' tasks (Q6), most teachers (64%) disagreed. The analysis of Q6 corresponds with Motabele's (2020) findings regarding the fact that most teachers are resistant to integrating teaching tools into their lessons due to increased workloads and inadequate time. Hence, only a handful of teachers (29%) perceived robot teachers as capable of marking learner's assessments, tests and exams much more effectively than human teachers.

Q7 and Q10 were structured to assess the same objective from the respondents, albeit they were only phrased differently as a way to aid critical thinking and clarity. Q7 and Q10 sought to investigate one of the major crises faced by South African schools about violence and lack of discipline in schools. Figure 16 shows that the data distribution of Q7 and Q10 are not symmetrical, but rather both data sets are skewed to the left. Analysis shows that Q7 corresponds with Q10 because the majority of teachers (Q7 – 96% and Q10 – 84%) do not believe that robot teachers are capable of minimizing violence and maintaining discipline in classrooms much more effectively than human teachers.

As an illustration, Tega is a robot used to improve learner literacy by asserting language skills through storytelling for early development. The analysis on Q8 shows that 17 teachers (38%), were optimistic about robot teachers addressing language barrier challenges in South African schools since they can be programmed to speak multiple languages. However, the high number of teachers (62%) who did not agree with the aforementioned statement, indicates that teachers believe that the complexities of addressing language barriers through machines are not ideal.

To conclude what it entails to be a teacher, Q9 assessed each teacher's opinion and experience to understand what teachers thought regarding robots performing all tasks assigned to a teacher's role. Overall, Q9 shows that drawing from their own experiences of being a teacher, most teachers (83%) believe that robots cannot effectively perform all duties assigned to a teacher. This is justified by the (Batchelor & Petersen, 2019) argument that the complexities of teaching cannot be reduced to simple algorithms. Further analysis indicates that the complex tasks performed by human teachers do not correspond with the criteria used to distinguish tasks aligned with robotic automation

4.4.3 Teachers' perception of technological Unemployment

Figure 17: Teacher trends on technological unemployment.

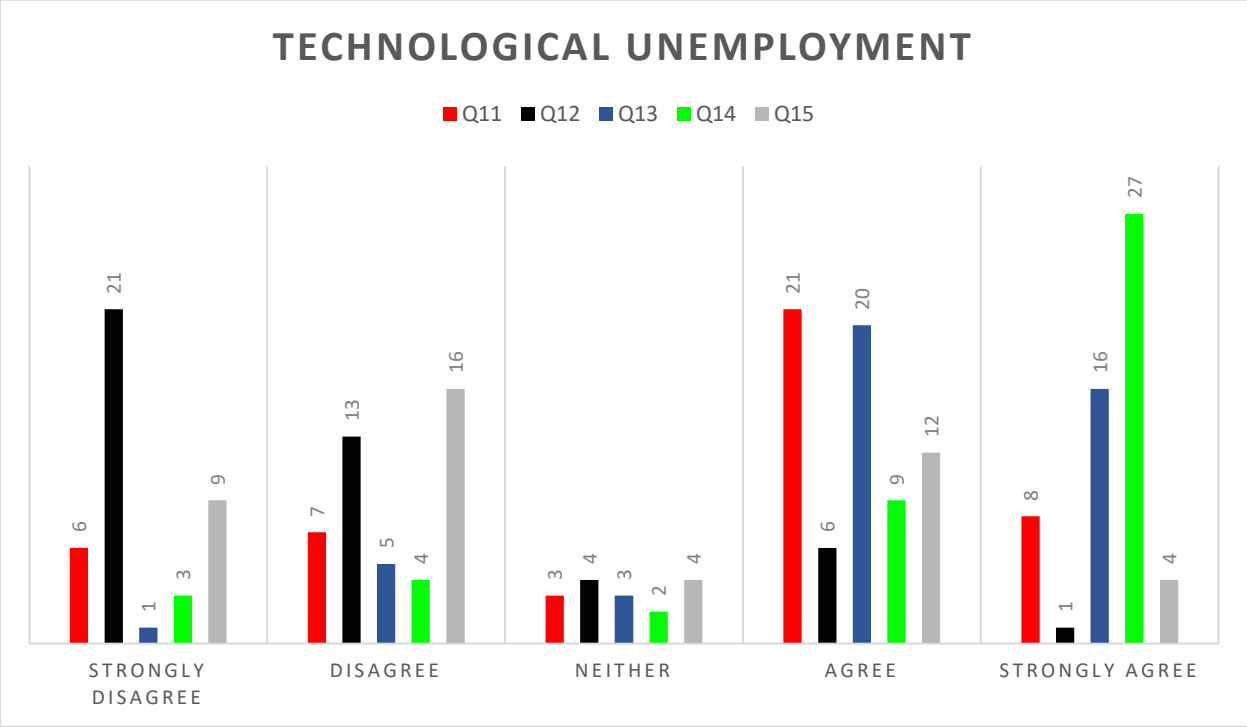


Table 14: Technological Unemployment.

No.	Question	Answers	SD	D	TOTAL DISAGREEMENT	Neither	A	SA	TOTAL AGREEMENT	OVERALL
Q11	Robot teachers can be employed in university and private spaces and not in primary/secondary schools.	frequency	6	7	13	3	21	8	29	45
		percentage	13%	16%	29%	7%	47 %	18 %	64%	100%
Q12	Deploying robots as teachers will create new job opportunities and roles for human teachers.	frequency	21	13	34	4	6	1	7	45
		percentage	47%	29%	76%	9%	13 %	2%	16%	100%

Q13	Robots can be employed to ONLY assist teachers in performing daily tasks in a classroom.	frequency	1	5	6	3	20	16	36	45
		percentage	2%	11%	13%	7%	44 %	36 %	80%	100%
Q14	Robots should NEVER be considered to replace teachers.	frequency	3	4	7	2	9	27	36	45
		percentage	7%	9%	16%	4%	20 %	60 %	80%	100%
Q15	The teacher role may be extinct in the future in response to new ways of learning remotely.	frequency	9	16	25	4	12	4	16	45
		percentage	20%	36%	56%	9%	27 %	9%	36%	100%

Figure 17 and Table 14 present a summary of the findings regarding how the respondents perceive technological unemployment in the teaching field. Interestingly, as stated above, the study found that a total of 33 teachers (73%) believed that it is not practically possible to employ robots in South African schools (primary and secondary). However, when analysing Q11 the study found that 29 teachers (64%) agreed that robot teachers can be employed in university and private spaces, just not in primary or secondary schools.

Scholars such as Chiacchio et al., 2018 and (Hötte et al., 2022) outlined that technological advancement does not always result in technological unemployment. Instead, technological advancement can result in *displacement or productivity effect.* In that regard, even though empirical literature (Bessen, 2015) suggests that technological advancement may result in the *Displacement or Productivity effect*, most teachers (76%) do not believe that deploying robot teachers will create new job opportunities and new roles for human teachers. Nonetheless, a few teachers (16%) are optimistic about new roles emerging in response to employing robots.

As the core findings of this study, the analysis of Q13 and Q14 summarized the most common teacher perception regarding the practicality of deploying robots in South African Schools. According to Q13, 80% of teachers feel and believe that robots should *only* be employed to assist teachers in performing daily tasks in a classroom. In correspondence with Orhani's (2023) findings, "teachers are not entirely opposed to robots helping them with daily tasks like grading, teaching, copying worksheets, and language translations (p. 39)". However, as projected in Q14 results, 80% of teachers highly believe that robots should *never* be considered to replace teachers. Therefore, what are the implications of the aforementioned findings? The results from the interview further explain the implications of these findings as presented below.

Table 15: Teacher Assistant.

Why should robots **ONLY** be employed to assist teachers in performing daily tasks in a classroom?		
Response	**Frequency**	**%**
1. Practicality, robots and machines are dependent on humans and cannot function solely on their own	0	0

2. Safety and security, robots are dangerous. Therefore, they need someone to monitor them in a classroom environment.	0	0
4. Implementation challenges, technical challenges and most people lack the higher level skills to maintain robots deployed in (primary and secondary) schools.	4	100%
5. I am uncertain about robots and their capabilities.	0	0
Total	4	100%

Table 15 provides the results from the conducted interviews. The results show that the interviewed teachers feel that robots should only be employed to assist teachers in performing daily tasks in a classroom because of implementation challenges. All 4 teachers (100%) believe that technicalities and the lack of people with higher level skills to maintain robots deployed in (primary and secondary) schools is the reason why robots can only presume an assistant's role. In line with most studies, Orhani (2023) argues that robots lack the independence necessary to function as fully independent teachers and that everything that they can do is based on programmable tasks, (i.e. machine learning and AI). Therefore, (Orhani, 2023)concluded that robots can assist teachers since it is unlikely that they can ever replace teachers.

In addition, empirical evidence from Ekstrőm and Pareto's (2022) findings indicates that teachers believe that the use of social robots can stimulate relevant skills and support curriculum objectives. While Alhashmi et al. (2021) found that on a scale of 1 to 10, learners at most rated a 10 indicating that they enjoyed the session of interacting with a humanoid teacher assistant. Therefore, it is highly justified why the study found that based on Table 15, 80% of teachers prefer robots to be deployed as assistance and not to replace them.

Table 16: Human teachers.

Robots should **NEVER** be considered to replace teachers.		
Response	**Frequency**	**%**
1. Teacher unions and teacher resistance. Teachers will resist this motion in fear of losing their jobs.	3	75
2. Robots' machines are dependent on humans. Robots cannot function independently without being monitored by humans	1	25
4. Role complexities. A Teacher's role is too complex for a robot to take over.	0	0
5. I am fearful of robots taking over.	0	0
Total	4	100%

In response to Q14, the last section of the interview survey asked respondents why they opted for the statement that robots should never be considered to replace teachers in the self-administered questionnaire. According to the findings of this section, the majority of respondents (75%) highlighted that teacher unions and teachers will resist this motion for fear of losing their jobs. Only one teacher (25%) felt that robots cannot replace teachers because robots' machines are dependent on humans since they cannot function independently without being monitored by humans.

In closing, the analysis of Q15 found that 56% of teachers believe that the teacher role will *not* be extinct in the future in response to new ways of learning remotely, while 36% felt otherwise.

4.5 Questionnaire Descriptive Summary

Table 17: Mean Summary.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
A Teacher job will be relevant in 20 years from now?	45	1	5	4.49	.968
Finding a teaching job in the future will be hard and rare.	45	1	5	3.62	1.093
Employing robot technology as a teacher is practically possible in South African schools.	45	1	4	2.04	1.021
Robot teachers can adapt to different school contexts, to effectively cater to different learners' needs.	45	1	5	1.98	1.177
Robot teachers can be equipped with substantial abilities to cater to learners' emotional and physical well-being.	45	1	5	1.96	1.224
Robot teachers can mark learners' assessments, tests, and exams much more effectively than human teachers.	45	1	5	2.40	1.372

A robot teacher is capable of maintaining discipline and managing classroom behaviour much more effectively than a human teacher.	45	1	4	1.51	.661
Robot teachers can address challenges associated with language barriers in South African schools since they can be programmed to speak multiple languages.	45	1	5	2.58	1.530
As an experienced teacher, would you trust a robot to effectively perform all the tasks assigned to it as a teacher?	45	1	5	2.04	.999
Robot teachers can increase security and minimize violence in classrooms.	45	1	4	1.91	.874
Robot teachers can be employed in university and private spaces and not in primary/secondary schools.	45	1	5	3.40	1.321
Deploying robots as teachers will create new job opportunities and new roles for human teachers.	45	1	5	1.96	1.147
Robots can be employed to ONLY assist teachers in performing daily tasks in a classroom.	45	1	5	4.00	1.044

Robots should NEVER be considered to replace teachers.	45	1	5	4.18	1.267
The teacher role may be extinct in the future in response to new ways of learning remotely.	45	1	5	2.69	1.311
Valid N (listwise)	45				

Figure 18: Weighted mean scale.

Likert Scale	Interval	Description
1	1.00-1.50	Never
2	1.51-2.50	Rare
3	2.51-3.50	sometimes
4	3.51-4.50	often
5	4.51-5.00	always

Source: adapted from Pimentel (2010)

To give a verbal description of a 5-point Likert scale, (Pimentel, 2010) suggested an interval of means, which enables the interpretations of weighted mean as seen in Figure 18. Using a similar measurement to interpret the overall summary of teacher perception, the study calculated a weighted mean for each question item based on the respondent's response, as seen in Table 17. Thereafter, using the mean value found in Table 17, the researcher cross-checked the value with Table 18 for interpretation and analysis. Based on the interval in Table 18 below, if the weighted mean is on the lower side of the scale, then it suggests a more negative response, while the contrary is applicable for a higher mean value.

Table 18: Weighted mean Summary.

Likert Scale	**Interval**	**Description**
1	1.0 – 1.50	Strongly Disagree
2	1.51 – 2.50	Disagree
3	2.51 – 3.50	Neither
4	3.51 – 4.50	Agree
5	4.51 – 5.00	Strongly Agree

Overall conclusions (based on the majority)

On the overall findings on how teachers feel regarding job insecurity due to deploying robots, the study found that according to Table 17, most teachers ($\bar{x}$ = 4.49) highly agree that a Teacher job will be relevant for the next 20 years. On the other hand, they merely Agree that ($\bar{x}$ = 3.62) that finding a teaching job in the future will be hard and rare. However, most teachers ($\bar{x}$ = 2.04) disagree with the notion of deploying robot technology as a teacher because they perceive it as impractical or unrealistic.

In addition, the overall results on Technological Advancement indicate that most teachers ($\bar{x}$ = 1.98) believe that it is just unlikely for robot teachers to adapt to different school contexts as a way to effectively cater for different learner needs. The majority of teachers ($\bar{x}$ = 1.96) also believe that robot teachers are not able to cater for a learner's emotional and physical well-being. Let alone ($\bar{x}$ = 2.40) trust robot teachers to assess and ($\bar{x}$ = 1.51) discipline learners much more effectively than a human teacher. Based on their experience, most respondents ($\bar{x}$ = 2.04) do not trust a robot to effectively perform all the tasks assigned to it as a teacher. Including ($\bar{x}$ = 1.91), the ability to increase security and minimise violence in classrooms. Unsurprisingly, the study found that most teachers ($\bar{x}$ = 2.58) believe that robot teachers cannot be used as a tool to address language barriers in South African schools.

Lastly, regarding the notion of technological unemployment, most teachers ($\bar{x}$ = 3.40) agree that robot teachers can be employed in university and private spaces and not in primary or secondary schools. The majority of teachers ($\bar{x}$ = 1.96) feel that deploying robots as teachers will not create new job opportunities for human teachers, but should robots be employed, most teachers ($\bar{x}$ = 4.00) think that robots should be employed as assistants and human teachers ($\bar{x}$ = 4.18) should never be replaced by robot teachers. In closing, results show that teachers ($\bar{x}$ = 2.69) believe that the teacher role will not be extinct in the future in response to new ways of learning remotely.

Theme 3: Factors influencing teacher perception

4.6 Factors influencing teacher perception

4.6.1 Gender

In line with the topic of enquiry, this study asked respondents to indicate their gender. Some research shows that females are more technophobic (fearful of technology and its innovations) than males (Kotzé et al., 2016). As seen in Table 19 below, of the 26 female teachers who participated in the study, only 1 female teacher (4%)[2] Strongly agreed that robot teachers can be equipped with substantial abilities to cater for learners' emotional and physical needs, whereas 59% were in strong disagreement. Out of the 19 male teachers, 7 male teachers (37%)[3] Strongly agreed with the aforementioned question while only 7 were in strong disagreement (37%). Therefore, in this context, males and females perceived the capabilities of a robot differently.

Table 19: Gender Difference.

Robot teachers can be equipped with substantial abilities to cater for learners' emotional and physical needs.		
	Female (n=26)	Male (n=19)
Strongly Disagree	15	7
Disagree	7	5
Neither	2	0
Agree	1	7
Strongly Agree	1	0
Total	**26**	**19**

[2] As per Table 4.1.2, n=1/26= 0.038= 4 % (percentage rate is calculated exclusively from Male teachers).
[3] Similarly as per Table 4.1.2 n=7/19 0.368, =37%. (Percentage rate is calculated exclusively from female teachers).

4.6.2 Subject specialization

Teachers were asked to specify their subject specialization with the objective being to distinguish if the different teacher's background knowledge had an impact on how they perceived technological advancement. However, analysis shows that the two CAT teachers differed in response when asked whether the teaching role would be extinct in the future due to new ways of learning remotely. Table 19 below shows that both ICT teachers are female and within the age range between (20 – 29). Respondent S1 from a quintile 4 school believes that the teaching role will not be extinct in response to new ways of learning remotely. On the other hand, respondent U2 from a quintile 5 school believes the contrary.

Table 20: Specialization Difference.

The teacher role may be extinct in the future in response to new ways of learning remotely.					
ICT					
Respondent	**Quintile**	**Gender**	**Experience**	**Age**	**Response**
S1	4	Female	2	26	Strongly Disagree
U2	5	Female	1	28	Agree

*(S1= School 2 and U2= School 3)

4.6.3 Quintiles

Table 21: School Quintiles.

	Quintile 1			Quintile 4			Quintile 5		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
A Teacher job will be relevant in 20 years from now?	16	4.50	.816	13	4.54	.877	16	4.44	1.209
Finding a teaching job in the future will be hard and rare.	16	3.31	.946	13	4.00	1.000	16	3.63	1.258
Employing robot technology as a teacher is practically possible in South African schools.	16	2.25	1.238	13	2.23	.927	16	1.69	.793
Robot teachers can adapt to different school contexts, to effectively cater to different learners' needs.	16	1.94	.929	13	2.15	1.519	16	1.88	1.147
Robot teachers can be equipped with substantial abilities to cater to learners' emotional and physical well-being.	16	2.06	1.289	13	2.00	1.414	16	1.81	1.047

Robot teachers can mark learners' assessments, tests, and exams much more effectively than human teachers.	16	2.19	1.276	13	1.69	.855	16	2.63	1.360
A robot teacher is capable of maintaining discipline and managing classroom behaviour much more effectively than a human teacher.	16	1.50	.632	13	2.38	1.557	16	1.38	.500
Robot teachers can address the challenges of language barriers in South African schools since they can be programmed to speak multiple languages.	16	2.69	1.537	13	2.62	1.710	16	2.44	1.459
As an experienced teacher, would you trust a robot to effectively perform all the tasks assigned to it as a teacher?	16	2.06	.929	13	2.38	1.387	16	1.75	.577
Robot teachers can increase security and minimize violence in classrooms.	16	1.81	.750	13	1.92	1.038	16	2.00	.894

Robot teachers can be employed in university and private spaces and not in primary/secondary schools.	16	3.81	1.047	13	3.23	1.589	16	3.13	1.310
Deploying robots as teachers will create new job opportunities and new roles for human teachers.	16	1.94	.854	13	2.46	1.391	16	1.56	1.094
Robots can be employed to ONLY assist teachers in performing daily tasks in a classroom.	16	3.88	1.258	13	4.23	.725	16	3.94	1.063
Robots should NEVER be considered to replace teachers.	16	4.19	1.109	13	4.08	1.441	16	4.25	1.342
The teacher role may be extinct in the future in response to new ways of learning remotely.	16	2.31	1.250	13	2.54	1.330	16	3.19	1.276
Valid N (listwise)	16			13			16		

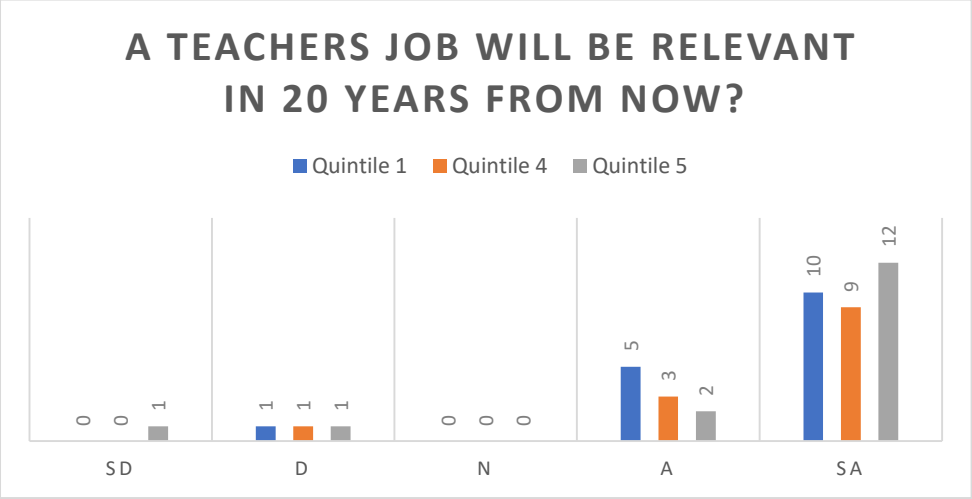
Based on Table 21, the different school quintiles have no significant difference when interpreted using the weighted mean per school. As illustrated in Table 21, most questions had a similar weighted average per question. However, only minor differences were found in Q2, Q11 and Q15 and were further explored as displayed below.

Table 22: Quintile difference.

Question	Scale		
	Quintile 1	Quintile 4	Quintile 5
Q2JI	3	4	4
Q11TU	4	3	3
Q15TU	2	3	3

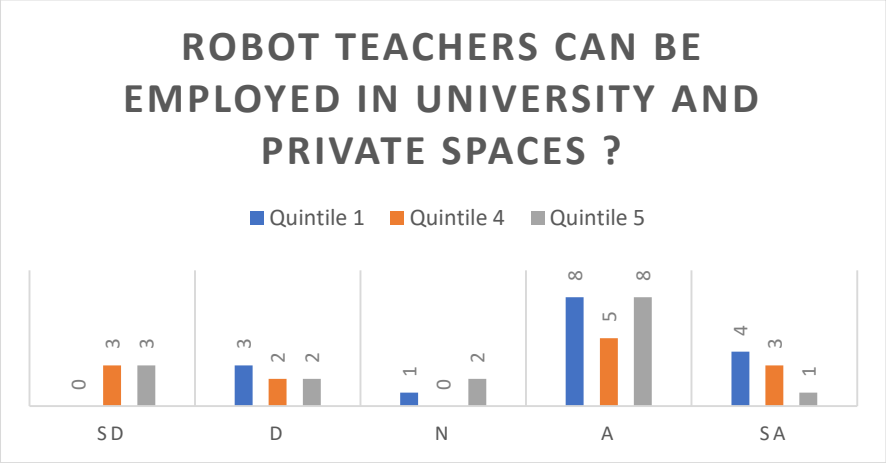
(Weighted mean scale as per Table 17 cross-checked with Table 18)

Figure 19: Q2JI.



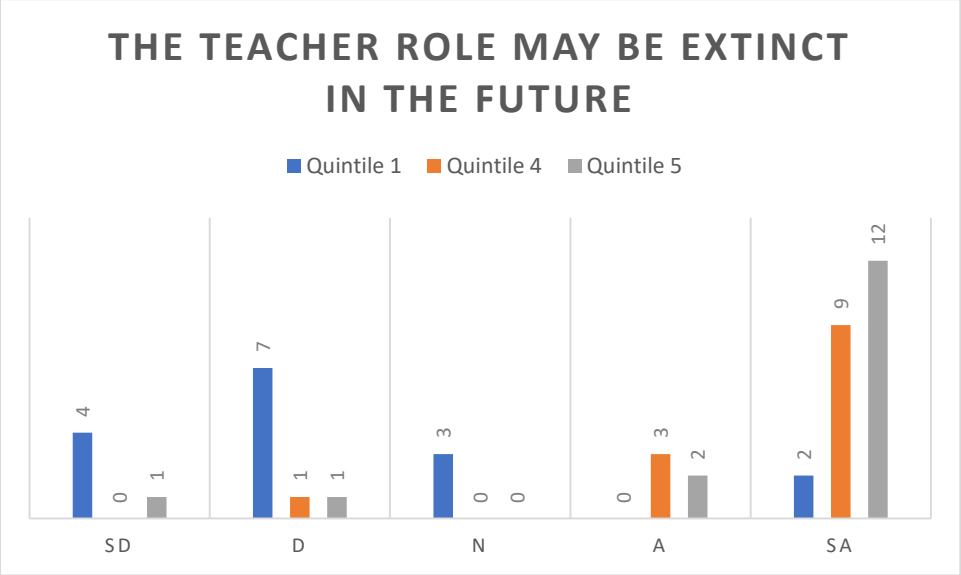
According to Figure 19, it is clear that there is no significant difference between the schools' teacher perceptions. The only minor outlier is that 1 teacher from Quintile 5 chose to strongly disagree, which had an impact on the central tendency of the weighted mean. However, all quintile graphs for each school are skewed to the right.

Figure 20: Q11TU.



Similarly, the analysis of Q11TU indicates that based on Figure 20, there is no major difference in perception between school quintiles. All bar graphs for each school are skewed to the right.

Figure 21: Q15TU.



As seen in Figure 21, quintile 1 is skewed to the left while quintiles 4 and 5 are skewed to the right. Question 15 is the only question with clear differences in perception.

4.7 Reliability and Validity

In the discourse of social sciences, the quantification of human behaviour is paramount. Therefore, it is crucial for the measurements provided in this study to be reliable and valid. Validity is concerned with whether the instrument used was able to measure the intended construct and how well the construct was measured (Sürücü & Maslakçi, 2020). Reliability, on the other hand, is concerned with the stability of the measured values obtained in repeated measurements under the same circumstances. The sections below, present the reliability and validity analysis of the study using Cronbach's Alpha, Exploratory Factor Analysis (EFA) methods as suggested by (Sürücü & Maslakçi, 2020) All the Tables provided in the section below, present data from the statistics software SPSS v.26.

4.7.1 Cronbach's Alpha

Cronbach's Alpha measures the internal consistency of a test or scale ((Kennedy, 2021)). Internal consistency entails the extent to which all the items in the scale measure the same concept or construct. Therefore, it is implied that the interconnectedness between constructs affects the value of alpha expressed between 1 and 0. To elaborate on this notion Kennedy (2021) states that

> "For a perfectly reliable measure, the reliability = 1. Now, if we have a perfectly unreliable measure, there is no true score, that is, the measure is entirely in error. In this case, the reliability = 0. The value of a reliability estimate tells us the proportion of variability in the measure attributable to the true score. A reliability of 0.5 means that about half of the variance of the observed score is attributable to truth and half is attributable to error (p.19)".

Therefore, for a study to be deemed reliable, it needs to comply with the accepted alpha value threshold.

Relevant to this section, according to Ahdika's (2017) study, Cronbach's alpha scores are categorized as 0.0 – 2.0 (Less reliable); >= 2.0 – <4.0 (rather reliable); >= 4.0 – < 6.0 (Quite reliable); >= 6.0 – <0.80 (reliable); and 0.8>= – 1. 00 (very reliable). Similarly, Surucu & Maslakci, (2020) highlighted that a study with an alpha value of <= 5 presents no internal

consistency; while an alpha value between 6 and 7 presents an accepTable internal consistency of the scale. Therefore, in both the aforementioned studies above (Ahdika, 2017); and Surucu and Maslakci, (2020) the findings of this study prove that the scale used was reliable. As seen below in Table 23a, the constructs of Q3 to item Q15 have a Cronbach Alpha score of 0.708, meaning that the items from question 3 to question 15 measured the same construct – teacher's perception of technological unemployment and technological advancement.

Table 23a: Cronbach's Alpha.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.709	.722	13

Table 23b: Item statistics.

Item Statistics				
	Mean	Std. Deviation	N	Cronbach's Alpha
Q3-T	2.04	1.021	45	7.09
Q4-T	1.98	1.177	45	
Q5-T	1.96	1.224	45	
Q6-T	2.40	1.372	45	
Q7-T	1.51	.661	45	
Q8-T	2.58	1.530	45	
Q9-T	2.04	.999	45	
Q10-T	1.91	.874	45	
Q11-T	3.40	1.321	45	
Q12-T	1.96	1.147	45	
Q13-T	4.00	1.044	45	

Q14-T	4.18	1.267	45	
Q15-T	2.69	1.311	45	

However, as seen Table 24b below indicates that the Cronbach alpha score for Q1 – Q2 was 0.092, which was a score below the accepTable Threshold. This implies that the construct measured in question 1 (item 1) and question 2 (item 2) were not consistent in measuring teachers' perceptions of job insecurities, which proved to be unreliable. Even when reverse coding was applied, Cronbach's alpha had no significant value. Nonetheless, the main items (Q3 – Q15) of the study measured the underlying construct with consistency and thus were reliable.

Table 24a: Cronbach's Alpha.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.094	.095	2

Table 24b: Item statistics.

Item Statistics				
	Mean	Std. Deviation	N	Cronbach's Alpha
Q1-JI	4.49	.968	45	0.094
Q2-JI	3.62	1.093	45	

4.7.2 Exploratory Factor Analysis [4]

4.7.2.1 KMO and Barlett's Test of Sphericity

Exploratory factor analysis (EFA) is a statistical procedure used to reduce a large number of observed variables to a small number, which enables the identification of underlying relationships between small numbers of variables (Hadia, Abdullah & Sentosa, 2016). Hadia et al. (2016) suggest that EFA is a useful research tool to investigate relations among observed variables. To determine whether the data set is appropriate for EFA, the study took into consideration the sample size (Tested through Kaisers-Meyer-Olkin: KMO); and the strength between the different variables by measuring the multivariate normality of the set distribution (Barlett's Test of Sphericity).

The rule of thumb suggests that a KMO value < 0.5 is unacceptable. While a value between 0.5 and 0.7 is mediocre, a value of 0.8 to 1 is adequate. However, Hadia et al. (2016) found that the sampling is sufficient if the KMO value is > 0.5; while Mashego (2022) suggest a KMO value > 0.6. Lastly, the p-value measuring Bartlett's Test of Sphericity must be < 0.05.

Table 25: KMO results.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.620
Bartlett's Test of Sphericity	Approx. Chi-Square	216.762
	df	105
	Sig.	<.001

The results of this study indicate that the KMO value is 0.62, which is above the recommended threshold. Secondly, the findings revealed that Bartlett's Test was significant because the p-value was 0.01. Meaning that the findings suggested that the sampling size and the strength between the different variables were significant to performing an EFA.

[4] This section utilized the three studies as a guideline to generate advanced analysis (Field, 2005; Hadia, Abdullahand & Sentosa, 2016; and, Mashego, 2022).

4.7.2.2 Factor Extraction

The extraction method refers to the smallest number of factors that can adequately explain a set of variables' interrelationships. This method is used once an adequate EFA has been established (Mashego, 2022). There are various methods to conduct factor extraction, although the three most common include Kaisers Criterion or Eigenvalue (EV) rules; Scree test and Parallel Analysis (Hadia et al., 2016). The most used method for factor extraction is Kaiser's criteria where components are factored and retained if the Eigenvalue is > 1. Based on the findings, only 6 items were factored as prevalent as shown in the Total Variance Table below. This implies that Q1 – Q6 best explain the underlying factor and essential information on the observed variables which were Job insecurity, Technological advancement and Unemployment.

Table 26: Variance explained.

Total Variance Explained						
	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.945	26.300	26.300	3.243	21.620	21.620
2	1.934	12.896	39.196	1.817	12.111	33.731
3	1.546	10.308	49.504	1.728	11.519	45.250
4	1.238	8.250	57.754	1.509	10.058	55.308
5	1.047	6.982	64.736	1.244	8.292	63.600
6	1.041	6.937	71.673	1.211	8.073	71.673
7	.891	5.938	77.611			
8	.783	5.218	82.829			
9	.616	4.109	86.938			
10	.583	3.888	90.826			
11	.456	3.041	93.867			
12	.339	2.259	96.126			

13	.289	1.924	98.049			
14	.193	1.288	99.337			
15	.099	.663	100.000			
Extraction Method: Principal Component Analysis.						

Table 26 shows that there are prevalent factors with a total cumulative variance of 71.86%. This means that 71.6% of the variance in the study can be explained mainly by these 6 factors. In emphasis, it was further explored that the first Eigenvalue is equal to 3.945 which explained 26.3% of the variance. Followed by the second Eigenvalue of 1.93 it explained 39.1% of the variance. The third Eigenvalue is equal to 1.546 and it explains 49.5% of the variance. The fourth eigenvalue is 1.238 and it explains 57.7% of the variance. The fifth eigenvalue is 1.047 and it explains 67.7% of the variance. Lastly, the sixth eigenvalue is 1.041 which explains 71.6% of the variance.

4.7.2.3 Implications (Field, 2005)

EFA is considered a statistical tool available to social science researchers for conducting research that is theoretically, empirically, and/or practically relevant ((Reio & Shuck, 2015) This is because EFA is used to develop questionnaires that will measure an ability or trait in line with the research conducted. EFA reduces the number of items to a more manageable measured construct to avoid redundancy.

The Total Variance Explained as shown in Table 26 displayed 15 linear components within the data set before extraction (Field, 2005). The EV associated with each factor represents the variance explained by that particular linear component which is also displayed in percentages (Field, 2005). As discussed question 1 (component 1), explains 26.3% of the variance in the data set. It is also observable that the EV decreases from components 1 to 6 (EV>1) and 7-15 (EV< 1).

Thus, out of the 15 items from the questionnaire, the first 6 retain the most important information even when the data has been reduced or simplified. The EV > 1 rule is such that eigenvalues greater than 1 can be interpreted as a factor while values less than 1 would not be. The SPSS analysis retained 6 out of the 15 questions (items) that had an EV> 1 meaning that

the 6 items with a total variance of 71.8% explain the pattern in the data through the factor analysis technique.

4.8 Chapter Summary

This chapter analysed, interpreted and discussed the findings of the data collected from the teachers. The results explored and explained how teachers perceive technological advancement, technological unemployment and job security in South African public schools. The data was quantified and measured using descriptive statistics through Excel and SPSS v.26. The following chapter presents the discussion and recommendations based on the findings of this empirical study.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.1 Introduction

In this chapter, the researcher evaluates the main questions and discusses the findings. There are four questions in correspondence with the research objectives. Drawing from the literature review, analysed data, graphs and Tables this chapter summarises the important findings.

(Note* O1, O2, O3, O4= Research Objectives; Q1, Q2, Q3, Q4= Research Questions)

5.2 Research Question One

O1: Investigate whether teachers are concerned with the notion of technological unemployment within their field.

Q1: Are South African teachers concerned about technological unemployment within the teaching profession?

Literature shows that teaching has always been regarded as one of the most secure occupations, therefore it is not surprising to note that most (teachers) opt for teaching as a career largely because they were assured that there are employment opportunities and job security (Lewis & Butcher, 2002). Deploying robots to replace teachers in classrooms would then entail that the teaching role would be automated resulting in job loss for teachers. In that regard, this study researched question Q1 and using descriptive analysis of the Likert-scale the findings show that most teachers do NOT fear job loss due to technology on the basis that they regard teaching as a most secure and relevant job, even in the future.

According to The South African Department of Education and Training, South Africa will encounter teacher shortages in the future due to increased learner enrolments creating the need for more teachers to complement the acceptable teacher-learner ratio (Van der Berg, Gustafsson & Burger, 2022). Hence, it is not surprising to note that the findings above indicate

that South African teachers highly believe that teaching is and will still be a secure job in the future.

However, finding a teaching job will be scarce and hard due to the competition in the labour market such as increased university enrolments (B.Ed. or PGCE); specialisation; increased number of immigrant teachers filling in posts and more (Mbokazi et al. 2023).

Based on the National Department of Basic Education school reality report from 2019, 2020, 2021 and 2022 this study analysed and evaluated the total number of learners, educators and schools over the past 4 years and the findings are illustrated below.

Table 27a: Ordinary public and independent school stats in South Africa.

	School realities report	**School realities report**	**Difference**
	2020	**2019**	**No.**
Overall Learners	13 216 472	13 041 198	175 274
Schools	25 199	24 998	201
Educators	442 940	444 857	(-1917)

Table 27b: Ordinal and independent school stats South Africa.

	School realities report	**School realities report**	**Difference**
	2022	**2021**	**No.**
Overall Learners	13 419 971	13 409 249	10722

Schools	24 871	24 894	(-23)
Educators	450 993	447 123	3870

Figure 22a: Teachers record.

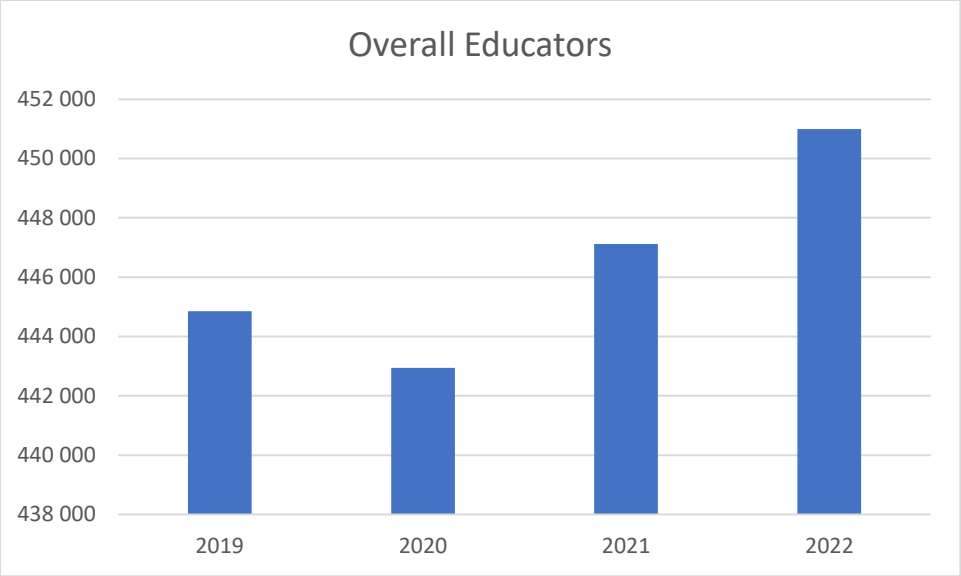
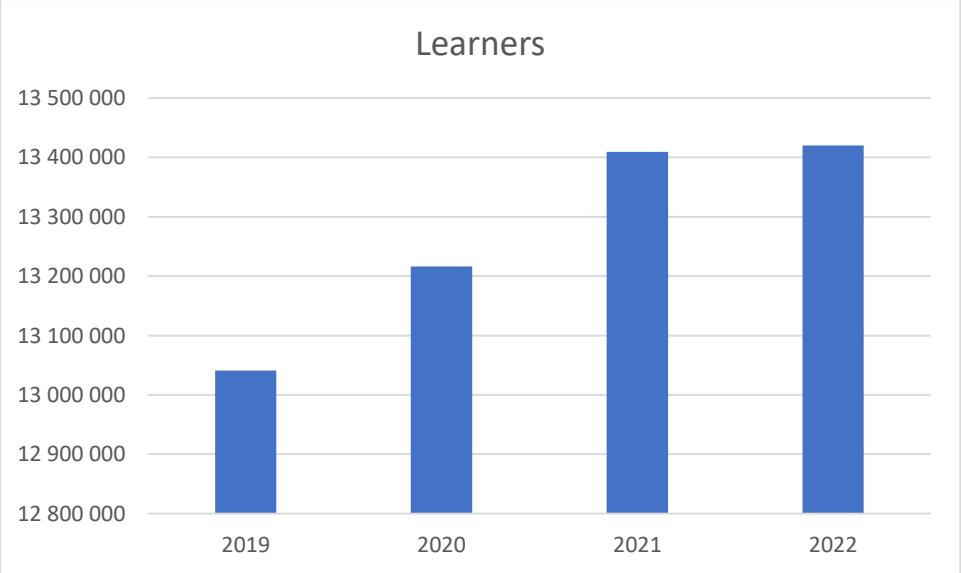


Figure 22b: Learners record.



Based on Figure 22a and Figure 22b, by comparing different school reality reports, this study found that there has been an increase in the number of learners over the past 4 years. In addition, the number of teachers has also increased except in 2021. Therefore, the study concludes and aligns with Van der Berg et al. (2022) study regarding the predicament of teacher shortage in

the future. It attests to the fact that in correspondence with teacher demand, as projected by the increase of learners over the 4 years, vacancies will be created to meet the demand.

5.3 Research Question Two

O2: Investigate and explore the differences in teachers' perceptions regarding robots replacing teachers in classrooms in the future or deploying robots as teacher assistants.

Q2: What are the differences in teacher perceptions regarding robots replacing or assisting teachers in classrooms in South African schools?

According to Global Data PLC (2016), a robot is defined as a piece of automated machinery that is designed and programmed to perform tasks faster than a human can and it is designed or created to protect and assist humans solve societal problems. Based on the (Global Data PLC, 2016) definition, it was found in this study that most teachers view a robot teacher as an assistant rather than an independent machinery that can take up the teacher's role.

This finding is substantiated by Tarantino (2022) who suggested that for automation to be successfully implemented, the task must be repetitive, too dangerous for a human to perform; too dirty; and cost-effective. However, according to the Personnel Administrative Measure (PAM, 1999) document these are the roles of a teacher in South Africa:

Table 27: Role of the teacher

"4.5 Teacher
(a) JOB TITLE: Educator – public school
(b) RANK: TEACHER
(c) POST LEVEL: 1
(d) THE AIM OF THE JOB:
To engage in class teaching, including the academic, administrative, educational, and disciplinary aspects and to organise extra and co-curricular activities to ensure that the education of the learners is promoted properly.
(e) CORE DUTIES AND RESPONSIBILITIES OF THE JOB:

The duties and responsibilities of the job are individual and varied depending on the approaches and needs of the particular school, and include, but are not limited to, the following:

(i) TEACHING

• To engage in class teaching which will foster a purposeful progression in learning and which is consistent with learning areas and programmes of subjects and grades as determined:

• To be a class teacher.

• To prepare lessons taking into account orientation, regional courses, new approaches, techniques, evaluation, aids, etc. in their field.

• To take on a leadership role in respect of the subject, learning area or phase, if required.

• To plan, coordinate, control, administer, evaluate and report on learners' academic progress.

• To recognise that learning is an active process and be prepared to use a variety of strategies to meet the outcomes of the curriculum.

• To establish a classroom environment which stimulates positive learning and actively engages learners in the learning process.

• To consider and utilise the learners' own experiences as a fundamental and valuable resource.

(ii) EXTRA- & CO-CURRICULAR

• To assist the HOD to identify aspects which require special attention and to assist in addressing them.

• To cater for the educational and general welfare of all learners in his/her care.

• To assist the Principal in overseeing learner counselling and guidance, careers, discipline and the general welfare of all learners.

• To share in the responsibilities of organising and conducting extra and co-curricular activities.

(iii) ADMINISTRATIVE

• To coordinate and control all the academic activities of each subject taught.

• To control and coordinate stock and equipment which is used and required.

• To perform or assist with one or more of other non-teaching administrative duties such as:

– secretary to general staff meeting and/or others,

– fire drill and first aid,

– timetabling,

– collection of fees and other monies,

– staff welfare,

– accidents.

(iv) INTERACTION WITH STAKE-HOLDERS

• To participate in agreed school/educator appraisal processes to regularly review their professional practice to improve teaching, learning and management.

• To contribute to the professional development of colleagues by sharing knowledge, ideas and resources.

• To remain informed of current developments in educational thinking and curriculum development.

• To participate in the school's governing body if elected to do so.

(v) COMMUNICATION:

• To co-operate with colleagues of all grades to maintain a good teaching standard and progress among learners and to foster administrative efficiency within the school.

• To collaborate with educators of other schools in organising and conducting extra and co-curricular activities.

• To meet parents and discuss with them the conduct and progress of their children.

• To participate in departmental committees, seminars and courses to contribute to and/or update one's professional views/standards.

• To maintain contact with sporting, social, cultural and community organisations.

• To have contact with the public on behalf of the principal. (PAM,1999)".

Thus, when analysing the task associated with the teaching role as prescribed in the PAM document (PAM, 1999) it is clear that a teacher's role is too complex for a robot to complete independently. Hence it is justified that 80% of teachers feel and believe that robots should *only* be employed to assist teachers to perform daily tasks in a classroom.

5.4 Research Question Three

O3: Investigate teachers' perceptions regarding the relevance and practicality of deploying robots in South African schools to enhance quality education in the future.

Q3: How do different teachers perceive the relevance and practicality of employing robot teachers, instead of human teachers in the future?

Most literature reviewed in this study mainly highlighted robot limitations as the barrier to successful implementation. To illustrate, empirical studies done abroad by scholars such as Van Ewijk et al. (2020) highlighted the issue of security and privacy; Applicability; Psychological welfare and happiness; and usability, as aspects that would hinder a successful implementation of educational robots. Similarly, Ekstrőm and Pareto (2022) further highlighted the time it took for the robot to perform a given task, technical shortcomings, limited social interaction and the robot being dependent on the teacher since at times, teachers felt the need to assist the student and robot interaction.

These findings correspond with the limitations presented by robots SAYA, PEPPER, RUBI and NAO presented in Chapter 2. However, results found in this study regarding the practicality of deploying robot teachers focused on environmental constraints, labour relations and inequalities.

According to the teachers that participated in the study, the main reason why it is not practical to deploy robot teachers is due to: firstly, inequalities permeating the South African education system hindering access. Secondly, Economic constraints result in poor infrastructure and a lack of resources. Thirdly, teacher unions and teachers will resist this motion in fear of teachers

losing their jobs. Lastly, Implementation challenges, there is a perception that most people lack the higher-level skills to maintain robots deployed in primary and secondary schools.

5.5 Research Question Four

O4: Investigate how a variety of factors influence South African teachers' perceptions of deploying robots in schools.

Q4: How do different factors such as school quintile, age and subject specialisation influence the teacher's viewpoint on deploying robots in South African schools?

5.5.1 Gender

According to analysis, the study found that more males were receptive towards equipping robots with emotional abilities to care for learners than females. This could be a result of perceived views on technology. Kotzé et al. (2016) indicated that females are more technophobic (fearful of technology and its innovations) than males, therefore gender was considered as one of the factors that impacted differences in perception.

However, in the context of emotional support and care in classrooms, perceived biological differences in societies are translated into mutually exclusive gender roles in which female teachers are associated with care for children rather than male teachers. This is because men are expected to exhibit masculinity in the form of aggressiveness and bold behaviour (Coleman, 2005). Thus, another reason why more females were not receptive to equipping robots with emotional abilities to care for learners was explained by the notion of gender role projection from society whereby females are perceived as caring in nature.

Lastly, about gender differences, it is worth highlighting that the difference in responses in terms of gender was mainly prevalent in this context of equipping robots with emotional needs. In other questions, gender had minimum observable differences in findings.

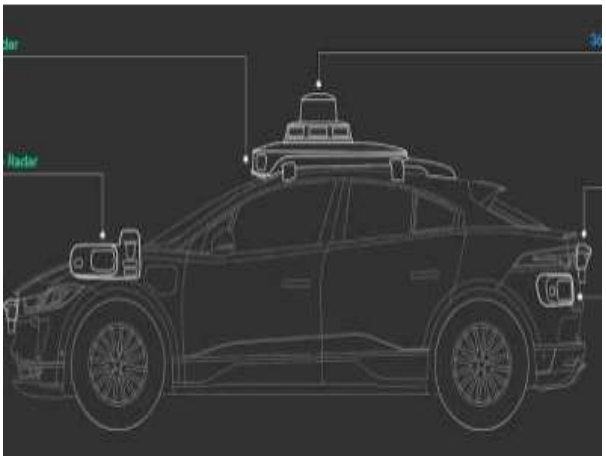
5.5.2 Subject specialisation

Analysis shows that even though teachers may teach the Same subject aligned to ICT, it does not necessarily mean that their views will align. For instance, the two CAT teachers differed in response when asked whether the teaching role would be extinct in the future due to new ways of learning remotely. The results indicate that the CAT teacher from the quintile 4 school indicated that the teaching role would not be extinct, which aligned with most of the non-ICT teachers' responses. While the quintile 5 CAT teacher agrees. It is worth noting that differences in perceptions are also linked to the teacher's experiences and how they view the world. Therefore, even though both teachers teach the same subject, it is justified that other factors influence their thinking and beliefs.

5.5.3 Quintiles

There were no prevalent observable factors impacting teachers' perceptions.

5.6. Overview of the study

Figure 23a: Cugnot's first Automobile.	Figure 23b: Waymo Driverless car.
	
Source adapted from (Lucendo, 2019).	source adapted from: (Singh & Saini, 2021)

A glance at the year 1769, when Nicolas-Joseph Cugnot invented the first Fadier à Vapeur (https://youtu.be/wr1MELVd0L4b) translated as Steam car (Lucendo, 2019). This first car invention could only pull 4 tons of weight and travel at a speed of 4 km/h. In comparison to the latest invention, the concept of driverless cars (self-automated vehicles) would have been ridiculed and seen as impractical in the year 1769. However, in the 21st century companies like Waymo (https://youtu.be/574rle_wA_E) have developed driverless technology (Wolmar, 2021)

Similarly, the concept of robot teachers should not be disregarded. Instead, there is a dire need to research ways of maximising the use of technology in education based on the account that the concept of technology assumes an important function in our everyday lives. Murshed, Marwan and Mohammed (2020), attest that technology resolves the most troublesome assignments in a flawlessly simple and more effective way. With the progression in technology, a vast number of scholars have contributed to the findings of multiple, consistent and innovative research to show new technologies that make education simpler, enjoyable, and available for all (Murshed et al., 2020). Since technological advancements are unpredictable and instantaneous, in the quest to remain globally relevant and in preparing for a digital society, we must understand the pros and cons of incorporating technology into education.

5.7 Contributions of the Study

5.7.1 Theoretical contribution to the education sector

In South Africa, the concept of unemployment is circulated apartheid and how it has contributed to the unequal distributions of skills, qualifications, and resources as a by-product of those who were previously disadvantaged during the apartheid era. Therefore, drawing from the concept of technological unemployment and job automation in the context of 4IR (Frey & Osborne, 2016); Luco et al., 2019) this study aimed to reveal teachers' perceptions of unemployment caused by deploying robots into the teaching profession.

5.7.2 Methodological contribution to the education sector

A case study conducted by Ewijk, Smakman, and Konijn (2020), investigated teachers' perceptions of deploying social robots in education using a qualitative approach. The focus of the study was to highlight concerns and opportunities related to robots and moral values in classrooms. The context of the study was solely based on 18 primary school teachers from the Netherlands – a developed country (Ewijk et al., 2020). Similarly, this study sought to investigate teachers' perceptions of deploying robots in education. Unlike the study by Ewijk et.al. (2020), my study took a quantitative approach and a positivist paradigm to understand different teacher's perceptions of unemployment caused by deploying robots in South African classrooms, which is a developing country. Therefore, the study was intended to provide findings that would contribute to the existing literature on teacher labour and an opportunity for quantitative research backed up by factual results from a quantitative approach.

5.7.3 Practical contribution to the education sector

In South Africa, the Department of Education (DoE) introduced the e-education policy to transform teaching and learning through technology to promote social growth in the country (Department of Education, 2004). However, the implementation of technology in South Africa is rather gradual than exponential in growth, and more progress should be made regarding how its integration benefits its users, particularly in education (Chomunorwa, Mashonanyika & Marevsa, 2023).

Because South African schools face multiple deprivations, it is not known whether the South African Government will seek to deploy robots in public schools in the future. Nonetheless, Chomunorwa et al. (2023) assert, that policymakers should extensively consider educators' perceptions whenever they intend on implementing any technological implementations in schools. Therefore, this study was intended to provide researchers and policymakers with empirical insight into how public school teachers feel and perceive the concept of the use of robots inside classrooms and the possible technological unemployment that might be caused by this deployment.

The second practical contribution intended was that policymakers need to constantly be informed about where technology is headed because, if workers are being replaced by robots,

policy needs to intervene on how unemployment and inequalities will be addressed (Bessen, 2015).

5.8 Recommendations

The recommendations of this study are intended to inform researchers, teachers and policy makers within the education sector.

5.8.1 Teacher labour

The concept of teacher unemployment is divided into optimistic and pessimistic predicaments based on different approaches (Bennell, 2023; Mapepa & Adekoye, 2019; Mbokazi et al., 2023; Van der Berg, et al., 2022). The study was able to explore the trend of teachers employed over the 4 years period based on the findings of the National Department of Basic Education school reality report from 2019, 2020, 2021 and 2022. With these findings, the researcher deduced that if the growing trend of learners increases, there will be a need for more teachers in the future. Therefore, this implies that the Department of Basic Education should review the school capacity regarding learner admissions into schools and how it influences teacher employment, classroom sizes, resources and textbook availability for the learners. In 2020, about 13 216 472 learners were enrolled in South African schools as cited in the School Reality report (Table 27a). However, by 2022 about 13 419 971 learners were enrolled, meaning that there is approximately an intake of 203499 learners.

5.8.3 Technology in Education

Studies reviewed for this research study indicated the use of a robot model in a classroom environment. The robot was used to interact with teachers and learners during lessons. This study found that while there is substantial amount of critics on humanoid teachers being deployed into classroom, it is worth noting that technological advancement in general promotes teaching and learning. On the notion that technology is meant to simplify our lives, this study

recommends that technology in the form of AI, Chabot's, teaching platforms and assessment software can facilitate tasks aligned with the teaching role. Teachers are encouraged to use technology as a way to present content in different teaching styles and methodologies.

5.9 Chapter Summary

In closing, the main objective of this study was achieved and the researcher found that most teachers are not threatened by their roles being replaced by robots. Rather, there was a positive view of robots assisting them perform their daily teaching tasks.

It is of paramount importance to emphasize that the profession of teaching plays a vital role in society (Sibanda, 2022). This chapter discussed key issues regarding how teachers perceive the concept of robots. In the following chapter, this study concludes and recommends future research gaps. In closing, the main objective of this study was achieved and the researcher found that most teachers are not threatened by their roles being replaced by robots. Rather, there was a positive view of robots assisting them perform their daily teaching tasks.

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APPENDIX A

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**24 August 2023**
Validity of Research Approval:	**08 February 2023– 30 September 2023** **2023/373**
Name of Researcher:	**Sitoe M**
Address of Researcher:	**3444 Vlakfontein ext 3 Kiasha Park**
Telephone Number:	***0817180895***
Email address:	
Research Topic:	**Investigating Teacher Perceptions on Technological Unemployment.**
Name of University:	**University of the Witwatersrand**
Type of qualification	**Masters in Education**
Number and type of schools:	**3 Secondary Schools**
District/s/HO	**Tshwane South**

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.

25/08/2023

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:

APPENDIX B

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG | WSoE Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

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

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: 2023ECE054M**
PROJECT TITLE	Exploring Teacher Perceptions on Technological Unemployment.
INVESTIGATOR	**MAIDA CARLOS SITOE**
SCHOOL/DEPARTMENT OF INVESTIGATOR	Wits School of Education
DATE CONSIDERED	June 2023
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	Minimal risk
EXPIRY DATE	Date of submission of the Research Report
ISSUE DATE OF CERTIFICATE	29 August 2023
CHAIRPERSON	Dr. Batseba Mofolo-Mbokane

cc: Dr Chakane More

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am are authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

_____ **26 / 08 / 2023**

APPENDIX C



1 Jan Smuts Ave,

Braamfontein, Johannesburg

South Africa

15 August 2023

Request for permission to conduct research

Dear: Principal _____

My name is Maida Sitoe, and I am a Masters's student at the University of Witwatersrand in Johannesburg. The research I wish to conduct for my Masters's Report is titled 'Investigating Teacher's Perception on technological unemployment'. This research will be conducted under the supervision of Dr More Chakane a lecturer at the University of Witwatersrand.

I am hereby seeking your consent to conduct my research in your school. The research includes teachers of any grade as participants who will answer a closed-ended questionnaire in the form of surveys. In addition, a few teachers will be interviewed and recorded during a quantitative interview. A quantitative interview consists of a series of closed-ended questions such as yes and no, providing locations and dates of events that occurred in the teacher's life. Lastly, I intend to collect any formal document that may add insight to the researcher's investigation.

I have attached a copy of my proposal which outlines the methods and instruments that will be used throughout the duration of the study. This also includes a copy of the Ethics certificate which is an approval letter by the Research Ethics Committee at the University of the Witwatersrand.

Upon completion of the research, the data collected will be kept for secondary use in my Ph.D. Furthermore, the main objective will be to evaluate the data to compile a full Masters report. As a researcher, I will ensure that the participants are not discriminated upon the duration of the study by obliging to regulations of Ethics issued by the University of the Witwatersrand. If you require any information regarding the study please do not hesitate to contact me Maida Sitoe at (1628079@tudents.wits.ac.za,0817180895). Alternatively, if you require further elaborations, please do not hesitate to contact my Supervisor Dr More Chakane at (M.Chakane@Wits.ac.za, 011717003).

Yours Sincerely

Student : Maida Sitoe(1628079@tudents.wits.ac.za,0817180895)

Supervisor: More Chakane (M.Chakane@Wits.ac.za, 011717003)

University of the Witwatersrand

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APPEDNDIX D

Participation Information Sheet (*questionnaire for all 45 teachers)*

Dear Sir/Madam

Warm Greetings, my name is Maida Sitoe. I am currently completing my Master's Degree at the University of the Witwatersrand. Supervised by Dr More Chakane, in the ELPS (Educational Leadership and Policies specialization). My research is focussing on exploring and understanding Teacher Perceptions on Technological Unemployment in South Africa.

I would like to invite you to participate in my study. Participation will involve answering a questionnaire which will take approximately +/-30 minutes to complete. Your participation is voluntary and you can withdraw at any time without needing to validate your reasons. Your responses will remain confidential and anonymity is assured. There are no options for personal details such as names or your student number to be filled out, so we will not know who you are.

No confidential information will be asked during the interview except Name and Surname as consent to partake in the study. The questionnaire provided contains closed-ended questions related to robotics and the unemployment of teachers. Your answers will not be regarded or graded as wrong or right. The study's main objective is to Gather your perception of how robots can replace teachers in their job roles in the future.

There will be no payments for participating as a volunteer in this research study and there will be no need for you as the participant to utilize your own money for anything related to the study

The completed surveys will be quantified to draw up conclusions to help draft the final research report to be submitted to the University of the Witwatersrand as part of the requirements for the master's degree completion. If you would like to receive feedback on how the data provided was transcribed and summarised you are more than welcome to receive a summary report.

In case you have any questions or concerns related to the questionaries' during the completion of the survey or after the surveys are collected you are more than welcome to contact me at this email
1628079@students.wits.ac.za. For further assistance, you can email my supervisor at More.chakane.wits.ac.za. For instance, if you feel that ethical procedures have not been adhered to, or would like to launch a complaint you have the right to and are welcome to contact the University of Witwatersrand education Ethics committee at Matsie.mabeta@wits.ac.za.

Yours Sincerely

M.Sitoe

APPENDIX E

Consent form

Title of Research: Exploring Teacher Perceptions On Technological Unemployment.

Investigator's Name and Surname: Maida Sitoe

I, ……., agree to participate in this research project titled Exploring Teacher Perceptions On Technological Unemployment.

Please Tick the relevant answer.

	Yes	No
1. I confirm that I have understood all the relevant information regarding my participation within the course of this research study.		
2. I Consent that I understand the contents of this research study.		
3. On the basis of the content being investigated, I consent to act as a participant by volunteering to share my knowledge and experience.		
4. I acknowledge that y participation is voluntarily and I can withdraw at any time with no need to validate to the researcher.		
5. I Understand that any responses I will provide, shall be treated with confidentiality and shall only be utilized for this research study as data collection.		
6. I Agree that my answers provided in the survey/Questionnaires will be used for the Research report.		

Name and surname of Participants:_____.

Signature of participants: _____.

Date: _____.

Name and surname of Researcher:_____.

Signature of Researcher : _____.

Date: _____.

APPENDIX F



Questionnaire

User Survey Questionnaire

Title: _____.

Date:_____.

Name of school: _____.

Age: _____.

Year of experience teaching:_____.

Subject teaching:_____.

Guides to the respondents

The questionnaire provided contains closed-ended questions related to robotics and unemployment of teachers. Your answers will not be regarded or graded as wrong or right.

Please indicate using a ✓ the most relevant answer according to your own understanding:

	Strongly Disagree	Disagree	Not Applicable	Agree	Strongly Agree
While technology is advancing at an instantaneous rate do you think…					
1. A Teachers job will be relevant in 20 years from now?					
2. Finding a teaching job in the future will be hard and rare ?					
3. Employing a robot technology as a teacher is practically possible in South African schools?					
4. Robot teachers can adapt to different school context, to effectively cater for different learners needs?					
5. Robot teachers can be equipped with substantial abilities to cater for learners emotional and physical wellbeing?					
6. Robot teachers can mark learners assessments, tests and exams much more effectively than human teachers?					
7. A robot teacher is capable of maintaining discipline and managing classroom behaviour much more effectively than a human teacher?					

8. Robot teachers can address the challenges with language barriers in south African schools, since they can be programmed to speak multiple languages?					
9. As an experienced teacher you would trust a robot to effectively perform all the tasks assigned to it as a teacher?					
10. Robot teachers can increase security and minimise violence in classrooms?					
11. Robot teachers can be employed in university and private spaces and not in primary/secondary schools?					
12. Deploying robots as teachers will create new job opportunities and new roles for human teachers ?					
13. Robots can be employed to ONLY assist teachers to perform daily tasks in a classroom?					
14. Robots should NEVER be considered to replace teachers?					
15. The teacher role may extinct in the future in response to new ways of learning remotely?					

APPENDIX G

Interviews

Participation Information Sheet (*face-to-face interviews and observations for the few selected teachers)*

Dear Sir/Madam

Warm Greetings, my name is Maida Sitoe. I am currently completing my Master's Degree at the University of the Witwatersrand. Supervised by Dr More Chakane, in the ELPS (Educational Leadership and Policies specialization). My research is focussing on exploring and understanding Teacher Perceptions of Technological Unemployment in South Africa.

I would like to invite you to participate in my study. Participation will involve a face-to-face interview whereby you answer 5 different questions. During these interviews, the researcher will record your answers with your permission. Your participation is voluntary and you can withdraw at any time without needing to validate your reasons. Your responses will remain confidential and anonymity is assured. After the interviews, the researcher will ask for your permission to observe your classroom activities with no interruptions, questions, or any activity that will disturb your lessons. Lastly, with your permission the researcher will ask to collect any formal documents such as lesson plans and any additional resources.

There will be no payments for participating as a volunteer in this research study and there will be no need for you as the participant to utilize your own money for anything related to the study

The answers to the questions answered during the interview will also be quantified to draw up conclusions to help draft the final research report to be submitted to the University of the Witwatersrand as part of the requirements for the master's degree completion. If you would like to receive feedback on how the data provided was transcribed and summarised you are more than welcome to receive a summary report.

In case you have any questions or concerns related to the interviews and classroom observation and any data collected you are more than welcome to contact me at this email

1628079@students.wits.ac.za. For further assistance, you can email my supervisor at More.chakane.wits.ac.za. For instance, if you feel that ethical procedures have not been adhered to, or would like to launch a complaint you have the right to and are welcome to contact the University of Witwatersrand education Ethics committee at Matsie.mabeta@wits.ac.za.

Yours Sincerely

M.Sitoe

Researcher

Maida Sitoe, 1628079@students.wits.ac.za, (+27 817180895).

Research Supervisor

More Chakane , More.Chakane@wits.ac.za, (0117173003).

APPENDIX H

RESEARCH INTERVIEWS



Researcher: Maida Sitoe.

Respondents name and surname: _____

Date _____ Time _____

Instructions to the Participant

- The interview instrument provided contains **5 closed-ended questions** and 4 possible answers related to robotics and unemployment of teachers.
- Choose one option of the **FOUR** that best explains your position.

1. In the questionnaire administered, you said a teacher's job will not be relevant in 20 years from now due to robots. Why did you say so? Choose one of the four statements below that best explains your answer to the questionnaire:

   A. Robots will be able to do everything that a teacher does in class.
   B. Government will opt for robots instead of teacher human beings who keep striking and staying away from work.
   C. Learners will demand to be taught by robots instead of human beings because they will be techno-survey.
   D. I am just fearful even though I do not have a good reason to say so.

2. In the questionnaire administered, you said finding a teaching job in the future will be hard and rare. Why did you say so? Choose one of the four statements below that best explains your answer to the questionnaire:

    A. The advancement of robots and artificial intelligence will create a new learning platform replacing traditional teachers and their teaching methods.
    B. The government will opt to deploy robots as a way to save cost and in response to globalisation (4IR).
    C. The teaching role will cease to exist and a new role will emerge in response to technology.
    D. Other motives that are not caused by advancement of technology.

3. In the questionnaire administered, you said employing a robot as a teacher is **NOT** practically possible in South African schools? Why did you say so? Choose one of the four statements below that best explains your answer to the questionnaire:

    A. Economic constraints, poor infrastructure and lack of resources.

    B. Diversity, robots lack the ability to interact and they cannot cater for different learner needs.

    C. Inequalities, the South African education system is characterised by high socio-economic inequalities, hindering access.

    D. I am just fearful even though I do not have a good reason to say so.

4. In the questionnaire administered, you said robots can **ONLY** be employed to assist teachers to perform daily tasks in a classroom? Why did you say so? Choose one of the four statements below that best explains your answer to the questionnaire:

    A. Practicality, robots and machines are dependent on humans and cannot function solely on their own.

B. Safety and security, Robots are dangerous. Therefore, they need someone to monitor them in a classroom environment.

C. Implementation challenges, most people lack the higher level skills to maintain robots deployed in schools.

D. I am uncertain about robots and their capabilities.

5. In the questionnaire administered, you said robots should **NEVER** be considered to replace teachers? Why did you say so? Choose one of the four statements below that best explains your answer to the questionnaire:

A. Teacher unions and teacher resistance. Teachers will resist this motion in fear of losing their jobs.

B. Robots' machines are dependent on humans. Robots cannot function independently without being monitored by humans.

C. Role complexities. A Teachers role is too complex for a robot to take over.

D. I am fearful of robots taking over.