Exploring creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special learning needs.

by

KEKANA KATANE ELIZABETH

Submitted in fulfilment of the requirements for the

MASTER'S DEGREE IN TECHNOLOGY EDUCATION

in the

DEPARTMENT OF MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

FACULTY OF HUMANITIES

SCHOOL OF EDUCATION

SUPERVISOR: MR T.I. MTSHALI

CO-SUPERVISOR: PROFESSOR M.S. RAMALIGELA

2024

ABSTRACT

To improve the learning of learners with exceptional needs, teachers are increasingly using creative teaching tactics. Teachers that use creative teaching tactics assist learners grasp the application of basic scientific abilities as well as the acquisition of conceptual information in difficult areas such as Technology. To teach a topic like Mechanical Systems and Control, which aims to equip learners with building facility knowledge and skills using various machines including gears, belts, chains, elevators, and escalators, amongst others, it is crucial that Technology teachers know creative strategies to use to teach learners with poor concentration span and autism.

The purpose of this study was to explore creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special needs in the Capricorn district of Limpopo. This study used a qualitative exploratory case study design. A homogenous purposive sampling was used to select two Technology teachers from two special schools in the Capricorn district. Data was collected through non-participant observation and semi-structured interviews. This study used Shulman's (1987) Content and Pedagogical Knowledge theory as its framework.

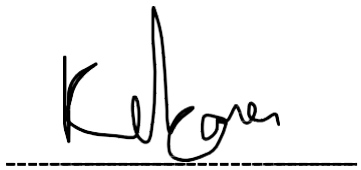
The present research found that Technology teachers had major hurdles in identifying and use adequate creative teaching strategies to deliver Mechanical Systems and Control content to learners with special needs. These teachers could not activate their Pedagogical Content Knowledge to keep learners engaged in the lessons as some of them were learners with autism and needed creative strategies from teachers to increase their concentration span.

The research revealed that even though Technology teachers used PowerPoint presentation slides, narrative discourses, textbooks, and artefacts during instruction, these strategies were not always effective for learners with special needs. This study recommended that teachers undergo a robust training on how to teach learners with special needs, focusing on the different pedagogies and methods such as the guided exploration method, technology integration, visualisation, and technological artefacts to better teach Mechanical Systems and Control concepts. These methods are learner centred and allow teachers to cater for learners' individual learning needs.

Key words: Special needs, Technology, Mechanical Systems and Control, Creative teaching strategy, Pedagogical content knowledge.

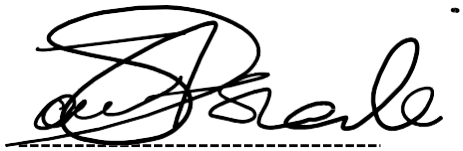
DECLARATION

I declare that the study entitled “Exploring creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special learning needs.” submitted to the University of Limpopo, as a requirement for the Master’s Degree in Technology Education, is my own work. This study has not been submitted to any University, College, Institution of Higher Education or any other University by anyone. I, therefore, state with full confidence that it is my own work in design and execution, and that all material contained has been fully acknowledged.



13/08/2023

STUDENT NAME: DATE:



13/08/2023

SUPERVISOR 1 DATE

13/08/2023

SUPERVISOR 2 DATE

ACKNOWLEDGEMENTS

I would firstly like to thank Jehovah, the Almighty God for giving me the strength, courage, perseverance and wisdom for the completion of this study. I give my sincere thanks, too, to the following:

My supervisor Mr T. I. Mtshali and co-supervisor Professor M.S. Ramaligela who have been patient and encouraging. I appreciate your contributions during this study; through it all you held my hand and I have survived.

My family, mom, dad and brothers. I appreciate you all for always being there for me and supporting me throughout this journey.

My academic buddy Ms M.P Magolego who has taken her own time to contribute positively to the completion of this study. Thank you too to all my classmates for their advice, motivation and support throughout the study.

All the participants who cooperatively participated in this study and gave valuable insight into the study.

My editor for editing this dissertation.

DEDICATION

This dissertation is dedicated to my supportive family, my mother, father, aunt, son and brothers: Nthabeleng and Thato Kekana.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

List of tables **Page numbers**

List of figures **Page numbers**

LIST OF ANNEXURES AND APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

ACE	Advanced Certificate in Education
CAPS	Curriculum and Assessment Policy Statement
CK	Content Knowledge
DBE	Department of Basic Education
DOE	Department of Education
HOD	Head of Department
Mini-PAT	Mini-Practical Assessment Task
NCLD	National Centre for Learning Disabilities
PCK	Pedagogical content knowledge
PGCE	Postgraduate Certificate in Education
SACE	South African Council for Educators
SIAS	Screening, Identification, Assessment and Support
SNE	Special Needs Education
STD	Secondary Teachers Diploma
TREC	Turfloop Research and Ethics Committee
TVET	Technical and Vocational Education and Training

CHAPTER 1

INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION AND MOTIVATION

Creative teaching strategies are becoming a crucial professional skill for teachers to enhance the learning of learners with special learning needs (Setiawan et al., 2021). The use of creative teaching strategies by teachers helps learners to master the application of basic scientific skills and the acquisition of conceptual knowledge in challenging subjects like Technology (Setiawan et al., 2021).

It can be difficult to teach learners at times, but it can be especially difficult to teach learners with different learning needs. Learners with autism, hyperactivity, and short attention spans attend our schools. Like every other learner in a public or private school, these learners require to receive a high-quality education. We cannot, however, ignore the fact that learners with special learning needs demand extra attention, thus teachers must choose pedagogical approaches and materials wisely to make sure these learners understand the material.

Teachers can quite readily know what to do while teaching learners who are disabled such as to be on a wheelchair or have low vision because to the abundance of ideas found in literature. But little is known about how to instruct a learner with a short attention span. It is impossible to completely rule out the possibility that some teachers have made progress toward instructing these types of learners.

According to Pazin, Maat and Mahmud (2022), teaching strategies such as demonstration, guided exploration method, technology integration, technological artefacts and visualisation are some of the leading effective strategies that could be used for learners with special learning needs (Pazin et al., 2022). This is because of their ability to improve learner participation in solving problems through learning. Learner participation is crucial in learning the concepts of Mechanical Systems and Control, as it emphasises on learning through experience.

According to Mathabatha, Kola and Mtshali (2022) the Technology subject requires high levels of learner participation as most of its contents require hands-on experience. Thus, it is crucial to understand creative strategies that Technology teachers could use to provoke a learner centred environment to learners with special learning needs. Hence, this study sought

to explore creative teaching strategies for teaching Mechanical Systems and Control to learners with special needs.

Studies pertaining to addressing learning difficulties associated with learners with special learning needs are scarce in a vocationally based Technology, especially when one looks into creative teaching strategies. Hlophe and Ramrathun (2020) supports this view that the teaching events of learners with special needs have not received adequate attention whilst the country needs vocational skills from all kinds of learners in schools. Owing to this gap in the research, it is important that this study first unpacks the benefits of using creative strategies during instruction.

According to Pazin et al. (2022), the use of creative teaching strategies assists in promoting critical thinkers and problems solvers. Also, Suyudi, Rahmatullah, Rachmawati and Hariyati (2022) propound that creative teaching strategies are effective in helping learners with special learning needs because they encourage the learner-centred approach. Nevertheless, all learners regardless of their ability require a friendly learning environment.

However, for the learners with special needs, more should be done in terms of the classroom setup and teaching strategies (Olimov, 2021). So, in terms of classroom setup, resources such as charts, overhead projector, laptop and smartboard are the learning tools that can help learners to learn with ease. This is because the National Centre for Learning Disabilities (NACLED) Marhalim (2013) avers that a proportion of the learners with special needs have a learning challenge that affects their ability to learn, hence learning tools play a huge role in facilitating a creative learning environment.

Teachers teaching learners with special needs such as autism, intellectual difficulties and behavioural disorder are compelled to find creative teaching strategies to teach Technology to cater for their learning needs (Hlophe & Ramrathun, 2020). Owing to this, this study delved into under-researched yet empirical observation on creative teaching strategies for teaching Mechanical Systems and Control to learners with special needs, thus contributing knowledge to the Technology learning discourse.

The No Child Left Behind Act of 2001 also calls for the teachers to be highly competent and it stresses the need for content knowledge to be delivered to the best of teachers' abilities (Rosenberg, Sindelar & Hardman, 2004). Makgato (2014), on the other hand, claims that Technology teachers are still struggling to find and use appropriate ways of providing

Technology content knowledge. For instance, the Mechanical Systems and Control topic in Grade 9 requires learners to learn about levers, inclined plains, screws, gears, and pulleys. The learning of this content involves performing experiments, hands-on practical investigations and making working models. However, there has not been enough literature on how the teachers based in the Limpopo province's special needs schools teach the Mechanical Systems and Control topic to the special needs learners. Hence the need to close this knowledge gap by exploring creative teaching strategies for learners with special needs.

1.2 CREATIVE TEACHING FOR LEARNERS WITH SPECIAL LEARNING NEEDS

To reiterate, creative teaching strategies are improved methods of teaching such as the use of visualisation, the guided exploration method, technology integration, and technological artefacts (Setiawan et al., 2021). Hence, there is an urgency to find creative strategies to use when teaching learners with special needs. According to Emerson (2016), special needs refer to human conditions such as physical, emotional, behavioural or impairment which causes a person to require specialised services or accommodation.

The above should not be confused with special educational needs which refer to learning problems where learners without impairments have more difficulties learning than most learners of the same age (Broomhead, 2013). This study is aligned with Broomhead (2013) version of special leaning needs. However, this study may intertwine the term special needs in the space of special learning needs. Therefore, this study explored the creative strategies for teaching Mechanical Systems and Control to learners with special learning needs.

According to Prater, Redman, Anderson and Gibb (2014) as well as Dodds and Hess (2020), most teachers still lack the knowledge and experience of teaching learners with special needs, particularly those with autism. Such sentiments have created a gap for this research, especially in the Technology subject which aspires for innovation in its content teaching.

According to Doyle (2020), the goal of teaching learners with special needs is to ensure their integration into society by offering equal and effective educational services in special education schools through inclusive education. However, with the pandemic having changed the modes of teaching and learning, and with the Technology subject requiring a practical assessment task, it remains a mystery what creative strategies the teachers are using to teach these learners Mechanical Systems and Control. There is a general stigma surrounding the teaching of learners with special needs (Mustafa, 2020).

It is believed that these learners have problems in intellectual aspects and adaptive behaviour. The teachers are constantly expected to support learners with special needs for them to continue their education and achieve their goals (Vincent-Lancrin, Cobo Romani& Reimers, 2022; Molina Roldán, Marauri, Aubert, & Flecha, 2021).

Online learning necessitated the use of mobile devices such as smartphones, tablets, and laptops, that could access information anywhere and at any time (Gikas & Grant, 2013). There are various infrastructures that support online learning such as the Google Classroom, WhatsApp, Kelas Cerdas, Zenius, Quipper, and Microsoft and these were used for teaching and learning during the pandemic. However, a study by Yazcayir and Gurgur (2021) reported that though the teachers tried to use WhatsApp groups to send worksheets to learners, unfortunately the teachers failed to give feedback to their learners. As a result, one might envision what procedures the teachers would have utilised to teach and provide feedback to learners with intellectual difficulties. Hence there is a need to explore this phenomenon.

1.3 STATEMENT OF THE PROBLEM

The untimely emergence of the pandemic and its impact on content and lesson delivery in schools, Technical and Vocational Education and Training (TVET) colleges and universities continue to challenge the use of conventional teaching strategies for special needs learners. It is impossible to ignore the need to enhance the current teaching practices. Besides, this comes at a time when most Technology teachers are still encountering challenges in creating learning activities that develop and maintain the continuity of hands-on skills. According to Mokoena, Matlakala, and Tladi (2014), the teachers need to be creative and innovative when delivering technological concepts and this includes Mechanical Systems and Control. Mechanical Systems and Control within technology aim to equip the learners with building facility knowledge and skills using various machines which include but are not limited to gears, belts, chains, elevators, and escalators (Department of Basic Education [DBE], 2014). Although the aims are clearly outlined in the policy document, the strategies to teach the content are still not clear. Furthermore, it is alarming that researchers have been relatively silent on how technology teachers can fulfil these goals for the learners with special needs, particularly during and after the pandemic; thus, this knowledge gap needs to be filled.

Thabethe’s (2018) contribution to the learning of mechanical systems in the Grade 9 Technology classroom by deaf learners highlights the gap indicated by this study. Thabethe (2018) found that the deaf learners had a misunderstanding of the mechanical systems

concepts and called for the teachers to use learning styles that match the individual needs of the learner to stretch the capabilities of the special needs learners. This study was motivated this call since not much research has been done to understand this phenomenon, especially in the Limpopo province. Understanding the creative strategies that are used by the Technology teachers can trigger or boost a more inclusive learner-centred approach. In addition, it can enhance the understanding of the Mechanical Systems and Control concepts for Grade 9 learners.

1.4 PURPOSE OF THE STUDY

The purpose of this research study was to explore how Technology teachers employ creative strategies to teach Mechanical Systems and Control to Grade 9 learners with special learning needs.

1.4.1 MAIN RESEARCH QUESTIONS

What are the creative teaching strategies for Mechanical Systems and Control to Grade 9 learners with special learning needs?

1.4.2 SUBRESEARCH QUESTIONS

How do Technology teachers creatively teach Mechanical Systems and Control to learners with special needs?

What are the pedagogical challenges encountered by the teachers when teaching learners with special needs?

How can the Technology mini-practical assessment tasks be aligned with the pedagogical needs of the learners with special needs?

1.5 AIM AND OBJECTIVES OF THE STUDY

The aim of this study was to explore how Technology teachers employ creative strategies to teach Mechanical Systems and Control to Grade 9 learners with special learning needs.

This study was further guided by the following objectives:

To understand how Technology teachers creatively teach Mechanical Systems and Control to learners with special needs.

To determine the pedagogical challenges encountered by the teachers when teaching learners with special needs.

To ascertain how Technology mini-practical assessment tasks can be aligned with the pedagogical needs of the learners with special needs.

1.6 RESEARCH METHODOLOGY

A qualitative approach was used in the study to apply the methods that were suitable for data generation (Cohen, Manion & Morrison, 2018; Creswell, 2013). An exploratory case study design was used to answer the research questions. Data were generated through non-participant observation and semi-structured interviews. Purposive sampling assisted in the identification and in the selection of the two Technology teachers in the Capricorn District in the Limpopo province. A comprehensive yet detailed segment of methodology is discussed in chapter 3.

1.7 SIGNIFICANCE OF THE STUDY

This study makes a major contribution to the research on the Technology subject, particularly studying how learners with special needs ought to be taught, which has attracted little research attention to date. It sheds insights into a highly complex blend of theoretical understanding and practical skills. More so, this study is significant in several ways. Firstly, it assists researchers to understand how Technology teachers creatively teach Mechanical Systems and Control to learners with special needs.

Secondly, it determines the pedagogical challenges encountered by the teachers when teaching learners with special needs. Lastly, to ascertains how Technology mini-practical assessment tasks can be aligned with the pedagogical needs of the learners with special needs. Thus, the findings of the study can benefit the Technology Grade 9 teachers, especially those teaching learners with special needs and those who have ambitions to teach at special schools.

In addition, the teacher training institutions can benefit from learning how best to train teachers to be competent when teaching learners with special needs. Furthermore, the creative teaching strategies can assist the Technology teachers to improve the teaching and learning process especially since the Covid-19 pandemic. Learners with special learning needs also could benefit from the study as the strategies employed would contribute to improving their performance. Learners would become active participants during lessons, provoked to become creative and critical thinkers as their learning needs would be met. This can assist in fulfilling the right to education for all and the right that no child be left behind.

1.8 EXPLANATION OF KEY TERMS

As a way of minimising misunderstanding and noting how terms are used in the context of this study, the key terms are explained below.

1.8.1 Learners with special learning needs

The general understanding of learners with special needs is that it is their special educational needs which make it difficult for them to learn at the same pace as their peers (Kekana, Mtshali & Ramaligela, 2023). In this study, learners with special needs refer to those that the study engaged with in a special school who have predominantly behavioural impairment such as autism, intellectual difficulties, and behavioural disorder.

Table 1.1: An outline of learners with special needs within the study.

Type of learners with special learning needs	Characteristics
a) Autism	Difficulty to relate to others, Repetition is crucial, lack of imagination. Sensory processing difficulty.
b) Intellectual difficulty	Low concentration span Difficulty recalling Difficult to think logically
c) Behavioural disorder	Difficulty concentrating Difficulty making friends. Low self esteem Persistent negativity

1.8.2 Mini-Practical Assessment Task (mini-PAT)

The mini-PAT is a hands-on practical activity that is given to the learners who are taking Technology to help them acquire the practical skills of the subject (Patricia, Isaac & Manto, 2023).

1.9 CHAPTER DIVISION

This dissertation is organised into five chapters.

Chapter 1: This chapter presents the introduction and background, preliminary literature, statement of the problem, research questions, methodology and, lastly significance of the study.

Chapter 2: Provides an overview of the literature regarding creative teaching strategies for teaching of Technology content. This includes outlining strategies for equipping learners with special needs, challenges encountered by special needs teachers and administering of mini-PAT assessments.

Chapter 3: A detailed description of the methodology used in this study is described in this chapter. It firstly explains the research approach and the research design. Furthermore, the chapter explains the population and sample, data collection instruments, and data analysis. Standards of rigour for research as well as the ethical considerations are also explained.

Chapter 4: This chapter presents the final analysis of results and summaries. This includes findings based on each research question and associated analysis.

Chapter 5: This final chapter provides a summary of the previous chapters, recommendations, and conclusions. The limitations of the study and future research are also presented.

1.10 SUMMARY OF THE CHAPTER

This chapter provided a brief account of the study. It presented a summary of how the research was conducted by outlining the background of the research as well as the educational context within which the study was conducted. The chapter highlighted the focus, significance, and the critical questions of the study.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

The previous chapter discussed the background of the research as well as the educational context within which the study was conducted. The chapter highlighted the focus, significance, purpose, and the critical questions of the study.

This chapter presents a review of literature and the conceptual framework pertinent to the purpose of this study. The literature has various focuses, the first one is the nature of creative teaching strategies within which creatively teaching Technology content and the discovery learning approach as a strategy are discussed. This is followed by technology integration, visualisation as a strategy for teaching learners with special needs, and technological artefacts. Again, barriers encountered by special education teachers who teach learners with special needs is discussed. The discussion focuses on teaching Technology subject knowledge and administering Mini-Pat Assessments. Lastly, conceptual framework.

2.2 NATURE OF CREATIVE TEACHING STRATEGIES

Many scholars, such as Pickard and Maude (2021), Setiawan, Munir and Suhartono (2019), Cremin (2015) and Rinkevich (2011), have various definitions of creative teaching strategies, depending on the context in which it is used. According to Pickard and Maude (2021), creative teaching strategies are inventive teaching strategies that help learners master the basic skills and also acquire conceptual knowledge.

Setiawan et al. (2019) define creative teaching strategies as teaching tactics which encourage meaningful learning, learner engagement, and peer interaction. Rinkevich (2011) construes the notion of creative teaching strategies as a process of planning and arranging education in such a way as to encourage students' use of thinking abilities, particularly creative thinking skills. In essence, creative teaching strategies are essential in the teaching of various educational contexts.

Cremin (2015) views creative teaching strategies as techniques that are processes of utilising creative processes and elements that involve creativity in the teaching process.

It also combines the teachers' creative qualities and creative thinking techniques which he or she uses to design the instruction strategies to enhance learning and motivate the learners. Creative teaching tactics are described as educational exchanges facilitated by the teachers that are "unique, customized and meaningful" (Rinkevich, 2011 P.225). Effective teachers should possess the ability to use creative teaching strategies to be able to cater for various learners in the classroom.

2.3 CREATIVELY TEACHING TECHNOLOGY CONTENT TO LEARNERS WITH SPECIAL NEEDS

Teaching is the process of passing on one's knowledge and experience to others, and it is usually arranged around a discipline (Suskie, 2018). Teachers can employ a variety of creative teaching strategies to improve their teaching and learning processes. According to Bryant, Bryant and Smith (2019), teachers are generally creative, except in instances where they are limited by resources. The teachers are also aware that they can use various strategies to enhance their teaching experience; however, their shallow knowledge on how learners learn becomes a hindrance (Bryant et al., 2019). This study is aligned to this view since there is not much research on how the learners with special needs learn.

Individuals with special needs receive education depending on their abilities, requirements, developmental features, and current performance level in special education. The professionals provide this education to suit learners' academic and social needs by using specifically planned educational programmes, resources, and methodologies (Diken, Rakap, Diken, Tomris & Celik, 2016).

During teaching and learning in a classroom, a variety of circumstances and activities arise. Most classes have learners with a diverse range of abilities, attitudes, and values (Bryant et al., 2019). According to Gilmour and Wehby (2020), regular teachers are teaching more learners with impairments. There are, however, limited academic contributions on how good teachers are at teaching them.

Technology was brought into the curriculum with the goal of generating the engineers, technicians, and artisans that are needed today, as well as the necessity to build a technologically educated population (DBE, 2011). The topic comprises a laboratory-based, hands-on curriculum that provides a firm basis for the application of theoretical concepts and is essential for future engineers' success (Basey, Sacket & Robinson, 2008). What is absent

though, is how teachers attempt to generate engineers who are special education beneficiaries.

2.4 DISCOVERY LEARNING APPROACH AS A STRATEGY FOR TEACHING LEARNERS WITH SPECIAL NEEDS

As part of the discovery learning approach, learners are encouraged to pose questions, come up with fundamental solutions, and draw general conclusions from concrete instances or personal experiences (Hanafi, 2016). According to Luque-Vega, Lopez-Neri, Santoyo, Ruiz-Duarte and Farrera-Vazquez (2019), discovery learning is a learning scenario in which the learner must independently find the main content of what is to be learnt. This includes observing, reflecting on what has been observed, and finding ways in which it could be applied in self-context and experiment, see Figure 2.1.

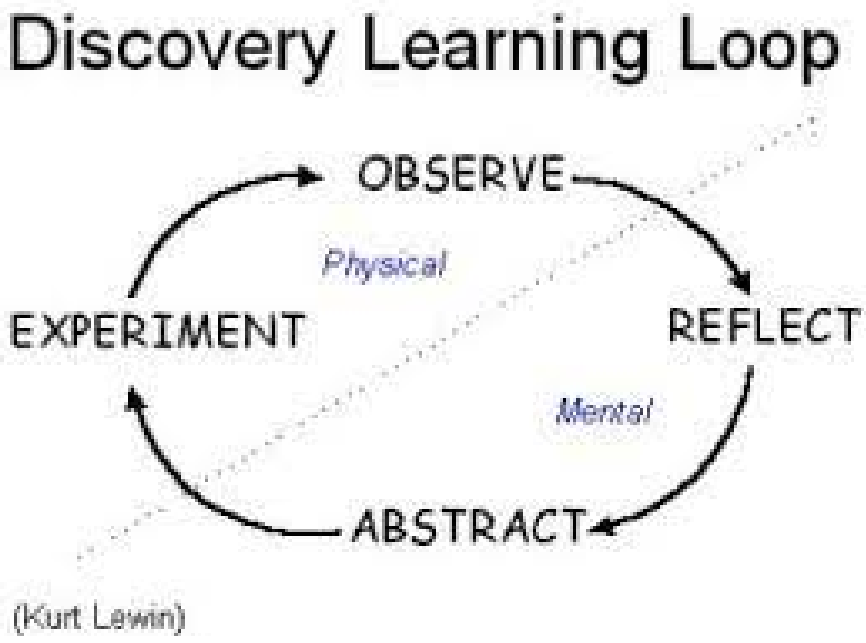


Figure 2.1. **Discovery learning loop by Kurt Lewin (1951)**

A study by Desyandri, Muhammadi, Mansurdin and Fahmi (2019 outlines that there have been improvements in learners' performance when taught using discovery learning. Desyandri et al. (2019) propound that discovery learning is effective as, within its mode, the learners are expected to take a significant part in many of the decisions on what, how, and when something is to be learnt. The learner is supposed to investigate examples and through them "discover" the principles or concepts that are to be learned rather than having the

content "told" to them by the teacher. This encourages learner-centred approach as the teacher becomes a facilitator.

2.5 TECHNOLOGY INTEGRATION AS A STRATEGY FOR TEACHING LEARNERS WITH SPECIAL NEEDS

Human life is affected by modern technology, which also affects education. Technology enables rapid accessibility to knowledge, thus explaining the reason its presence in the classroom is so crucial. Digital resources and networking are a big part of human life from an early age to old age. Progress in the field of technology and information has encouraged teachers to improve their efficiency and effectiveness in the classroom daily (Hodges, Kerch & Fowler, 2020). The development of information sources that can be accessed anytime, anywhere, and by anyone makes it easier for teachers and learners to obtain knowledge. Smartphones, computers, and tablets are already an inescapable feature of everyday life for learners and teachers worldwide (Sage, Jackson, Mauer & Stockdale, 2022). It is only natural that the usage of technology gadgets in the classroom are explored to create suitable educational opportunities for all learners, including learners with special needs.

Several researchers namely Kem, (2022); Routray, Sharma, Sahoo, Javali, Sharmila, and Akanksha, (2021) agree that the use of educational technologies has a positive impact on teaching and learning. According to Billingsley, Israel, and Smith (2011), using various forms of technology in the classroom, such as a virtual classroom, results in learners who are actively interested in what they are being taught. Technology integration also opens doors for individualised instruction to fulfil each learner's specific needs as an individual learner within a larger classroom environment.

Since the pandemic, the education paradigm of teaching and learning has changed. The utilisation of educational digital tools has a significant impact on teaching and learning success (Önal, 2021). For Önal (2021) the education system is crucial to a country's development and early education on the use of digitals has a positive impact on knowledge acquisition.

According to Kontostavlou and Drigas (2021), teachers are still "comfortable" where they are. Most teachers continue to prefer the teacher-centred approach to instruction. The researchers further explain that the most frequently used facilities at the school are the LCD projectors and school laptops, which are appropriate for using learning material in groups. The fact that learning may proceed normally is what matters most. However, it appears that

educators have not been very passionate or enthused about developing novel, unconventional learning approaches.

A study by Chaidi, Drigas, and Karagiannidis (2021) make the case that PowerPoint presentations can be used to teach a classroom idea while giving students the chance for interaction. Links to videos that support the concepts offered in the PowerPoint presentation set can be incorporated into the slides, in addition to the use of images and bulleted information.

Games can be used to engage students and improve teaching and learning (Li, Garza, Keicher, and Popov 2019). Studies have found that playing games helps students understand things better and gives them a place to express their creativity. Games work well as learning triggers because they get learners talking about concepts in a vibrant way. Li, Garza, Keicher, and Popov (2019) state that games play a unique role in boosting learners' self-confidence. Games can narrow the disparity between quick and slow learners.

According to Montiel, Delgado-Ceballos, Ortiz-de-Mandojana, and Antolin-Lopez (2020), educational apps like Kahoot can be utilised in the classroom to review material following a course or unit. While learners can create anonymous usernames to play the game, teachers can develop and share Kahoots with one another. Learners who might ordinarily be reluctant to participate in class can now participate. Teachers can choose whether they want their learners to work independently or in teams when using the Kahoot app, which can be played on computers or smartphones.

Technology such as computers, laptops, tablets, television, and smartphones help to address and equip learners with special needs with skills needed by autistic learners. However, Siyam (2019) have outlined how teachers complained that there were few resources to use at certain schools, which is a concern since autistic learners learn better with the use of the resources.

2.6 VISUALISATION AS A STRATEGY FOR TEACHING LEARNERS WITH SPECIAL NEEDS

To investigate the use of visualisation in the teaching and learning process for developing critical thinking, Nurbekova, Grinshkun, Aimicheva, Nurbekov and Tuenbaeva (2020) discovered that visualisation is beneficial for learners who find it hard to conceptualise through verbal explanations. Nurbekova et al. (2020) discovered that visualisation is impactful in the teaching and learning process, enhancement of critical thinking skills and on their

general performance. The findings also indicate that the image encourages learners to study, makes them more obedient, and helps them hone their critical thinking abilities.

Since the beginning of time, visual imagery has been a powerful tool for communicating both abstract and tangible ideas. Liang, Bethely, and Walia (2021) claim that because visualisation is a tool for understanding, one may talk about seeing an idea or an issue. To visualise a problem is to comprehend it as a visual (mental) image, so the visualisation process entails visual imagery, with or without a diagram, as a crucial component of the method of solution (Nurbekova, Grinshkun, Aimicheva, Nurbekov & Tuenbaeva, 2020).

One research in particular emphasises how crucial clear education is to ensure the successful application of visualisations in Technology. According to Presmeg (2020), visuals are helpful for understanding concepts. But without education in visualisation methods, learners frequently struggle to understand three-dimensional data. Bos, Miller, and Bull (2022) found that because they lack the same background knowledge as the individuals who generated the scientific visualisations, learners could be perplexed by them.

2.7 TECHNOLOGICAL ARTEFACTS

According to Frederik, Sonneveld, and de Vries (2011), technical artefacts are tangible things created by (human) actors as a method of achieving useful objectives. As defined by Preston (2020), an artefact is a physical item that an actor (or group of agents) generates by two, possibly simultaneous, conscious acts: the choice of a material entity (as the single element) and the assignment to a characteristic or capability. According to Wiseman et al. (2020), holding an artefact enables students to employ their senses as well as hone their questioning and problem-solving abilities. It also deepens their comprehension of a time.

A study by Risan (2020) on teaching with artefacts and special collections indicates that learners benefit greatly from handling artefacts because they employ their tactile and olfactory senses in addition to their visual and hearing senses, which increases engagement and memory. However, it is an educator’s obligation to provide knowledge about proper object management. Moreover, Subero, Llopart, Siqués, and Esteban-Guitart (2018) outline that learners may gain a greater grasp of history and an interesting glimpse into the past through items. In addition to being accessible to almost all learners, object-based learning also fosters the broader abilities of deduction and teamwork. Concepts like change and continuity may be brought to life through the context of objects.

2.8 CHALLENGES OF TEACHING MECHANICAL SYSTEMS AND CONTROL TO SPECIAL NEEDS LEARNERS

According to the Department of Basic Education (2014), teachers are the major resource and facilitators of achieving inclusive education. As a result, continuous and intensive training must be given to carefully advance their knowledge of teaching learners with special needs. For some years even up to the present, schools have been allocating teachers the subject of Technology without checking their professional qualification towards the teaching of the subject. This continues to hamper the progress of the Technology concept. As such, this study was motivated by this gap to explore if this is the same case for special needs learners. This is because Reinsfield and Lee (2021), Banks and Barlex (2020) and Florian (2019) reveal that there are high possibilities that underqualified Technology teachers still teach a lot of misconceptions, and their strategies are questionable.

According to De Jager (2011), a notable number of teachers in special schools are either never or rarely trained to teach learners with special needs. Walton and Lloyd (2012) add that most of these teachers still struggle pedagogically as most of them are trained to teach “ordinary” learners. Similarly, Ayaya, Makoelle, and van der Merwe (2021) and Micanovic, Novovic and Maslovaric (2017) claim that the teacher preparation for teaching learners with exceptional needs is insufficient; thus, this study stemmed from such a gap.

The special needs learners reveal that they are not supported and that their learning needs are not being met because of poor teacher training (Ayaya, Makoelle, & van der Merwe, 2020). Despite the Screening, Identification, Assessment and Support (SIAS) policy and White Paper 6, 2001 (Department of Education [DoE], 2001) having been implemented, it remains a monumental effort for an inclusive classroom teacher to put policy into reality (Engelbrecht, Nel, Smit, & Van Deventer, 2016). This clearly indicates that globally there has been an oversight on the education of special needs learners.

Hoang and Wyatt (2021) notes that most teachers face a challenge in delivering Mechanical Systems and Control knowledge to special needs learners because English is a foreign language to both the learners and the teachers. This is reasonable as most Mechanical Systems and Control content is in the English language. Another challenge is having overpopulated classes. In fact, having more than 60 learners per class puts the learners with special needs at a disadvantage in terms of being equipped with practical hands-on skills within the technology topic (Naude & Meier, 2019).

The teachers with large classes face additional challenges as a small class responds better than a large one (Beattie & Thiele, 2016). Mapotse and Gumbo (2013) conducted a study in the Limpopo province focusing on the teaching practices of Senior Phase Technology Education teachers. The findings reveal that the Mechanical Systems, Control, and Electrical Systems topics are quite challenging to participants. Moreover, there is a lack of knowledge by the veteran teachers in the field. In addition, Gumbo (2020) reveals that while the teachers received training by attending workshops, such training did not fully meet their needs and neither did it expand their Mechanical Systems and Control pedagogical content knowledge of Mechanical Systems and Control.

On the other hand, Mbuvha's (2018) study on the prominence of in-service training on the performance of special needs schoolteachers in South Africa in the Limpopo province reveals that most special schoolteachers are battling with employing teaching strategies that are accommodative and effective for the teaching and learning of learners with special needs. The teachers stated that teaching learners with special needs was challenging, as they are faced with more learners who have intellectual difficulties. Mbuvha's (2018) findings show that there is a lot of scope for research on teaching and learning in special education, particularly in the Limpopo province.

2.9 TEACHING TECHNOLOGY SUBJECT KNOWLEDGE AND ADMINISTERING MINI-PAT ASSESSMENTS.

Technology education is focused on identifying the people's wants and practices using science and resources to address those requirements. This covers problem solving as well (Makhubele & Simelane-Mnisi, 2021). Teachers play a critical role in the learning and teaching process for the learners throughout their education. Their responsibilities for teaching must ensure that they have experience in multiple subjects for them to be effective (Prozesky, 2000). As technology is founded on interdisciplinarity and overlaps with numerous fields of study (Mathematics, Science, Engineering, and Design), it may be quantified at the most fundamental levels using techniques from a specific section of Mathematics.

Fahrman, Norström, Gumaellus, and Skogh (2020) investigated experienced Technology instructors' teaching practices. The researchers in their study went into detail about Pedagogical Content Knowledge (PCK) in technology education, the knowledge of instructional strategies for teaching Technology, the knowledge of the Technology curriculum, and the knowledge of the pupils' grasp of the subject.

According to the study's findings, the teachers emphasise various goals for Technology instruction, but all agree that the instruction should be learner-centred, and they should also encourage active engagement. Furthermore, they stated that despite its time commitment, a practical-oriented teaching approach engages the learners to a high degree. Their research was pertinent to this study since it aimed to showcase how Technology teachers use creativity to teach Mechanical Systems and Control to special needs learners.

Furthermore, as part of the school curriculum, all the learners in the senior phase (Grade s 7-9) are required to take a Technology class. According to Makgatho's (2014) findings on the issues of teaching and learning Technology in South African schools, participating teachers believe that Technology can be taught effectively with the right resources, such as practical materials. Makgato (2014) found that successful teaching and learning is dependent on the required expertise, abilities, and the teachers' attitudes, not on the availability of resources. However, the author goes on to say that the education department should provide sufficient resources and materials to enable successful teaching and learning, as well as practical skills training and understanding of how to use the materials and resources.

2.10 CONCEPTUAL FRAMEWORK

This study used Shulman's (1987) Content and Pedagogical Knowledge notion to explore the creative teaching strategies that are used by the Technology teachers to teach Mechanical Systems and Control to Grade 9 learners with special needs. According to Shulman (1987), content and pedagogical knowledge supports teachers in transforming content knowledge into pedagogically effective forms. Despite this, the approach is adaptable to a wide range of abilities and backgrounds.

As a result, the goal of this research study was to better understand how Technology teachers transform learners with special needs' knowledge of Mechanical Systems and Control. Shulman (1987) classifies seven types of knowledge bases for teachers: Knowledge of content; general pedagogical knowledge; curriculum knowledge; pedagogical knowledge; knowledge of learners and their characteristics; knowledge of educational contexts; and knowledge of educational history and philosophy. See Figure 2.2 below.

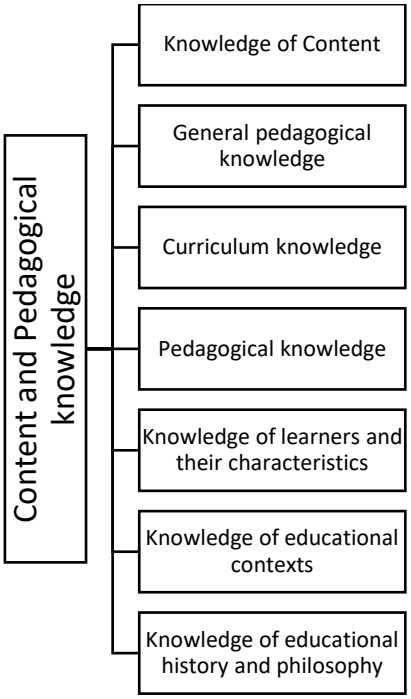


Figure 2.2 **Shulman (1987) Content and Pedagogical Knowledge**

Given the focus of this study, the following concepts were considered most relevant and were thus adapted to understand the phenomenon under scrutiny. The knowledge of content, pedagogical content knowledge, knowledge of learners and their characteristics and knowledge of educational contexts.

Shulman (1987) emphasises the Pedagogical Content Knowledge (PCK) domain, which he defines as the integration of content and pedagogy into high-quality teaching instruction. The understanding of learning challenges and the learners' ideas of specific topics are two sub-elements of PCK, according to the author.

2.10.1 Knowledge of content

According to Shulman (1987), Content Knowledge (CK) includes the knowledge of concepts, explanations, ideas, proofs, practical examples, as well as processes and models for developing this knowledge. This study regards content knowledge as the fundamental base that a teacher must possess. Therefore, CK in this study was used as the understanding of the content that the Technology teachers possessed for the Mechanical Systems and Control concepts. This of course cannot be separated from how the teacher presents it to the learners. This is because CK is conceived as an element of PCK.

2.10.2 Pedagogical Content Knowledge (PCK)

Shulman (1987) developed and identified Pedagogical Content Knowledge (PCK) as one of the important knowledge domains for instructors. PCK is described as knowing what makes learning specific topics simpler or more difficult. It is also the knowledge that includes both subject matter and pedagogical expertise (Shulman, 1987). PCK is defined as the type of knowledge that is required for the teachers to teach the subject, understand the learners' methods of thinking, recognise the learners' errors and their sources, and express specific themes in several ways (Shulman, 1987).

PCK entails offering the learners tasks, utilising their existing ideas and prior knowledge, and providing suitable instructional support and guidance in the form of explanations, analogies, illustrations, as well as examples to help them grasp the topic. As a result, PCK was used to investigate how Technology teachers teach Mechanical Systems and Control to learners with special needs in interesting ways.

2.10.3 Knowledge of the learners and their characteristics

The knowledge of the learners and their characteristics, according to Shulman (1987), refers to the teacher's understanding of possible learners' ideas of the issue. This is done to develop explanations that would either dispute or confirm the preconceived notions. This knowledge includes the teachers knowing the importance of acquiring core topic concepts and identifying the need-to-know approaches for assessing the learners' comprehension. The study has used the knowledge of the learners and their characteristics. This was used to learn the pedagogical challenges that are encountered by the teachers when teaching the learners with special needs.

2.10.4 Knowledge of educational context

According to Shulman (1987), the knowledge of educational context refers to the broadest sense knowledge of all the settings where learning takes place. It includes everything from an awareness of instructional situations to class and group social dynamics, to the broader aspects of school and community culture. This domain emphasises the use of educational technologies to improve teaching and learning. Hence, this study used knowledge of educational context to understand of how the Technology mini-practical assessment tasks are aligned with the pedagogical needs of the learners with special needs.

2.11 SUMMARY OF THE CHAPTER

This chapter provided a brief account of the study. The review of literature discussed several themes such as the nature of creative teaching strategies. Creatively teaching Technology content, the discovery learning approach as a strategy, technology integration, visualisation and technological artefacts were discussed as strategies for teaching learners with special needs. The challenges of teaching Mechanical Systems and Control to special needs learners and administering mini-PAT assessments were also considered. This chapter also presented a summary of the conceptual framework guiding the research study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter presented a review of literature and the conceptual framework pertinent to the purpose of this study. This chapter begins with an account of the research approach and research design. The population and sampling procedures are explained, followed by the data collection techniques and data analysis. The chapter concludes with a discussion of the trustworthiness of the qualitative instrument and ethical considerations.

3.2 RESEARCH APPROACH

A qualitative approach is a research method that focuses on obtaining data through conversational and open-ended communication (Yin, 2014). A qualitative approach which focused on the case study method was used in this study.

Firstly, the qualitative research approach was selected as the methodology for this study for the purpose of enabling me, after data analysis, to understand and explore the richness, depth, context, and complexity within which teachers in the research site operate (Peterson, 2019). The method is thorough, comprehensive, and delivers understanding of a continuous process rather than a brief overview (Sebele-Mpofu, 2020).

According to Gundumogula (2020), qualitative research is utilised to comprehend how people see the outside world. He goes on to say that while qualitative research can use a variety of methodologies, they all tend to be flexible and centre on preserving rich meaning when analysing data. Qualitative research is mostly used because it enables the researcher to understand the reasons for and processes of people's actions and experiences (Allan, 2020).

It is challenging to gather this knowledge through the gathering of quantitative data. In accordance with Clark, Foster, Bryman, and Sloan (2021), qualitative research includes travelling to individuals, institutions, and places to observe behaviour in real-world circumstances. Additionally, rather than putting existing ideas to the test, it generates abstractions, notions, or hypotheses (Bryman, 2016).

Secondly, qualitative research was conducted as this strategy is effective because it classifies, arranges, and interprets pertinent data that has been qualitatively acquired (Onwuegbuzie, Dickinson, Leech, & Zoran, 2009). The goal of this study was to shed light on social issues without disturbing the surrounding environment.

Qualitative research was thought to be the best fit for this research project because it is a suitable way of obtaining data through discussions, observations, interviews, and other sources. This is a perspective shared by Kitto, Chesters and Grbich (2008). It has also been affirmed by Roller (2019) who describes the qualitative method as an uncontrolled, interpretative and spontaneous strategy that relies on oral narration like written or spoken information.

Lastly, the qualitative research approach enabled me to achieve the aim of the study which was to explore creative strategies for teaching Mechanical Systems and Control to Grade 9 learners with special needs in the Capricorn District of Limpopo. Furthermore, the qualitative research approach allowed for the supply of the most effective tools for investigating perplexing phenomena and complicated systems.

3.3 RESEARCH DESIGN

The phrase "research design" is used in this source material to refer to all the choices made during the planning and execution of the research endeavour, from defining the problem to summarising and disseminating the results (Sileyew, 2019). As stated by Bloomfield and Fisher (2019), the study design is an actual strategy for the procedures to be applied, including sampling, data collecting, and data analysis, and is created in line with the methodology decisions that have been made. The research design describes the overall strategy, the setup, the participants, and the data gathering techniques.

Asenahabi (2019) asserts that research design aims to offer a suitable framework for a study. The research design is thus a strategy for responding to the study questions because it seeks to get a thorough knowledge and comprehension of creative teaching strategies for teaching Grade 9 learners with special needs. A research design, according to Pandey and Pandey (2021), is the path a researcher chooses to take when conducting research to obtain answers to a research topic as legitimately, independently, correctly, and inexpensively as feasible. A research design is therefore a strategy that the researcher determines and conveys to others about how they will gather information, analyse data, and present their results.

3.3.1 Case study

An exploratory case study design was used to explore the creative strategies that the teachers use to teach Mechanical Systems and Control to the learners with special needs. A case study is defined as a single entity, a unit with boundaries that can be a person, a

programme, a group, or a specific policy that focuses on a specific scenario, event, or phenomena (Yin, 2014).

As stated by Cohen et al., (2018), a case study offers a singular illustration of actual individuals in actual circumstances, allowing readers to comprehend concepts more clearly than by merely depicting them with abstract theories or principles. As noted by Bloomfield and Fisher (2019), a case study can take on a variety of shapes. For instance, a researcher can decide to focus on one school, jail, medical unit, or networking site.

The reason for using the exploratory case study design was basically to obtain extensive and in-depth information for the study (Yin, 2014). Thus, a single case study research design was suitable in this study because there were two special schools involved. The special schools were similar in that they both specialized in learners with autism, intellectual difficulties, and behavioural disorders. Participants used the same teaching and learning strategies. The focus this study was creative teaching strategies for teaching Mechanical Systems and Control to learners with special needs in the Capricorn District.

3.4 POPULATION

Population refers to a specific set of individuals or things that share the trait under investigation in a study (Sharma, 2017). Similarly, for Rahi (2017), population involves selecting a sample of participants who are representative of the total population and who have of common characteristics. The population of this study comprised of all the secondary schools that offer the Technology subject in Grade 9 within South and North Capricorn Districts, Limpopo Province, South Africa. I focused on the Grade 9 Technology teachers who were teaching learners with special needs in special schools.

3.5 SAMPLING

According to McEwan (2020), sampling is the process of selecting a sample from a population. This study employed the homogenous purposive sampling method and convenience sampling.

Zhi (2014) states that homogenous sampling is when the researcher focuses on the participants who share similar traits, which may be in terms of culture, job title and life experiences. I chose participants who were Grade 9 Technology teachers teaching learners with special needs and similar traits, particularly autism, intellectual difficulties, and

behavioural disorder. The objective was to concentrate on these specific similarities and how they pertain to the research topic.

The purposeful sampling technique was adopted in this study since the participants were chosen specifically to provide relevant information about the topic. Whitehead and Whitehead (2016) express the view that even if the sample group is not statistically representative of the larger population under consideration, researchers who practice purposeful sampling carefully plan how they can select their sample population.

This emphasis influenced the reason for using this kind of purposive sampling to allow me to make sample decisions while obtaining a better understanding of the context and taking advantage of events as they occur (Whitehead & Whitehead, 2016). Thus, using homogenous sampling enabled me to explore the creative strategies that the teachers use to teach learners with special needs.

Convenience sampling refers to the investigation of population subjects that are conveniently available to the researcher (Given Lisa, 2008). Similarly, Etikan, Musa and Alkassim (2016) describe convenience sampling as the practice of gathering data from participants who can be easily located and contacted. As such, I chose members who were located nearby, within the same district, for continuous collection of data. Moreover, the participants were familiar with me and could make arrangements easily on when I could come to revisit the schools.

For schools that are far away would make it difficult for me to visit the schools continuously. Observing and interviewing participants in a single lesson would not provide sufficient data for the study. More lessons needed to be observed including when teachers conducted the mini-practical assessment task. The study required the researcher to observe various lessons for about three weeks to gather sufficient data on how Grade 9 Technology teachers teach Mechanical Systems and Control to learners with special needs. As indicated earlier, the focus was on teachers teaching in a special school within the North and South Capricorn District.

3.6 DATA COLLECTION TECHNIQUES

In this case study research design, various data collection instruments were used. Non-participant observation and semi-structured interview tools were used to assist in obtaining data of the study. Instead of depending on a single technique of data collection, qualitative research enables researchers to gather a variety of data types, including observations,

interviews, and documents (Yin, 2014). The development of the questions and themes on the tools was guided by Shulman's (1986) PCK as the adopted theoretical framework for this study.

Special schools comprise various learners with special needs, for that principals were approached to enquire about the kind of special needs learners attending their schools. Two special schools were selected as both comprised of learners with autism, intellectual difficulties, and behavioural disorder. Each school met the requirement of having a Grade 9 Technology teacher. The letters of invitation to participate were then sent to the teachers.

One male and one female teacher were found within the same circuit. I briefed the participants about the study and completion of the consent form. Furthermore, I assured participants ethical considerations as stated in the study will be followed and fulfilled. Thus, participants were assured anonymity by being assigned pseudonyms, namely Teachers A and B. Data collection occurred from the beginning of term 2.

3.6.1 Non-participant observation

Non-participant observation is the practice of observing participants while abstaining from participation (Flannery, Healy, & Luna, 2018). Thus, non-participant observation involves researchers adopting a "fly on the wall approach" to observe people and organisations without interfering with their routine activities, as illustrated by Busetto, Wick, and Gumbinger (2020).

This study used the non-participant observation tool (Annexure A) to gather data on how Technology teachers creatively teach Mechanical Systems and Control to Grade 9 learners with special needs. The development of the observation tool was guided by the theoretical framework of Schulman's (1986) pedagogical content knowledge. The observation was conducted during teaching and learning to explore creative teaching strategies that Grade 9 Technology teachers employ to teach Mechanical Systems and Control to learners with special needs.

The observations occurred from the second week of term two when the concepts of Mechanical Systems and Control were to be taught. The participants were observed four times; each lesson lasting for 60 minutes. The observation schedule was structured in a way that the teaching strategies used by participants were noted, had guiding questions extracted from the theoretical framework, and had a section for comments.

Non-participant observations allow a researcher to collect real-time data from ongoing circumstances without interfering with the situation (Flannery et al., 2018). The tool was used to allow for a more impartial assessment of what was happening. Again, this was an overt observation as I collected data from the participants who had agreed to participate in the study. This was because I had a prolonged engagement with the participants, which allowed the data to be collected in a natural setting.

Video recordings, photographs and field notes were taken to capture the data collected during non-participant observation. Video recording was used to record strategies employed by participants, record instances where participants administer mini-practical assessment and teach learners. Field notes were taken from the responses of participants during interviews.

I collected data for this study as a non-participant observer. I did not take part in the teaching of Grade 9 learners with special needs but focused on the participants during lesson delivery.

Table 3.1: ***An outline of applicable themes for RQ1***

Research Question 1	**Theme / Concept applicable**
How do Technology teachers creatively teach Mechanical Systems and Control to learners with special needs?	Knowledge of content Pedagogical knowledge Knowledge of learners and their characteristics Knowledge of educational contexts

3.6.2 Semi-structured interviews

A semi-structured interview is a technique for gathering data that depends on formulating questions within a pre-established theme framework (Ruslin, Mashuri., Rasak., Alhabsyi, & Syam, 2022). Husband (2020) adds that interviews that are semi-structured have elements of both structured and unstructured interviewing. He also describes how open-ended, flexible semi-structured interviews are common.

Additionally, semi-structured enables a researcher to ask predetermined questions in a predetermined order, facilitating easy comparisons between respondents, but it can be constricting. While still allowing for comparisons between respondents, less structure can help a researcher spot patterns.

Semi-structured interviews were used to understand the challenges encountered by the teachers when teaching learners with special needs. Also, this tool was used to explore

how Technology mini-practical assessment tasks can be aligned to the pedagogical needs of the learners with special needs.

According to Terre Blanche, Durrheim and Painter (2014), semi-structured interviews are open and dynamic dialogues between the researchers and the participants, driven by a standardised interview procedure and complemented by follow-ups, surveys, as well as feedback. The semi-structured interviews were guided by Shulman's (1986) PCK theoretical framework to form a list of questions to be explored to extract data from the participants. Notes and audio recordings during interviews were considered to capture the entire interview process.

Table 3.2: ***An outline of applicable themes for RQ2 & RQ3***

Research question 2	**Theme/concept applicable**
What are the pedagogical challenges encountered by the teachers when teaching learners with special needs?	Knowledge of content Pedagogical content knowledge Knowledge of learners and their characteristics
Research question 3	**Theme/concept applicable**
How can Technology mini-practical tasks be aligned with the pedagogical needs of the learners with special needs?	Pedagogical content knowledge Knowledge of learners and their characteristics

3.7 DATA ANALYSIS

The process of making meaning of data is known as data analysis (Yin, 2014), Cohen et al. (2018) claim that organising data into themes, finding patterns and categories, and deriving meanings as defined and described by participants are all parts of qualitative data analysis. The collected data were analysed through thematic analysis using Shulman's (1987) content and pedagogical knowledge theory. Thematic analysis is a process for analysing qualitative data that involves examining across a data set to identify, analyse, and report repeated patterns (Braun & Clarke, 2006). It is a method for describing data, but it also involves interpretation in the processes of selecting codes and constructing themes. The data from the observation and the transcripts from the semi-structured interviews were analysed as follows.

3.7.1 Non-participant observation

The data from videos and pictures were transcribed manually into narratives and analysed. The two teachers' lessons observed were analysed descriptively. This studyused Shulman's (1987) knowledge of content and the pedagogical content knowledge domains for this segment. The written texts were checked to establish common and different issues and then were merged into the aforementioned themes (Table 3.2). As indicated earlier, the data analysed came from observing how Technology teachers creatively teach Mechanical Systems and Control to Grade 9 learners with special needs.

I summarised the data obtained by linking them with themes and the research questions. The knowledge of content domain assisted me analyse the teachers' content knowledge of Mechanical Systems and Control. The PCK domain assisted to analyse the information of how teachers present ideas, analogies, illustrations, examples, explanations and demonstrations pertaining to Mechanical Systems and Control.

3.7.2 Semi-structured interview

The data from semi-structured interviews were coded, analysed, and discussed thematically. The first section B (Annexture B) was used to analyse the pedagogical challenges encountered by the teachers when teaching learners with special needs. The last section C (Annexture B) were used to analyse how the Technology mini-practical assessment tasks are aligned to the pedagogical needs of the learners with special needs. Semi-structured interviews were analysed using semantic analysis.

The themes from Shulman's (1987) PCK, namely knowledge of the learners and their characteristics, as well as the knowledge of content domains, assisted in analysing the semi-structured interviews.

The collected data were examined, patterns were identified, and themes were pinpointed. Through thematic analysis practice, the codes and meaningful patterns were discussed (McMillan & Schumacher, 2010).

3.8 TRUSTWORTHINESS OF THE QUALITATIVE INSTRUMENTS

Stahl, and King (2020) outline that to establish trustworthiness of the study's findings, there must be evidence of four main criteria – credibility, transferability, dependability and confirmability.

3.8.1 Credibility

The term "credibility" refers to a match between the participants' constructed realities and the researcher's representations of them (Maxwell, 2021). I made use of a qualitative study to ensure credibility in this study.

According to Morris and Paris (2022), the accounts of human experience are regarded as credible if they are quickly recognized by people who have had similar experiences. In this case, non-participant observation and semi-structured interviews were employed to collect data.

To ensure credibility, lessons were videotaped to assure that what occurred during the lessons is not tempered to be untrue. Field notes were taken to outline what occurred during the observation and recordings of responses of participants during interviews. Furthermore, member checking was used, which refers to confirming the collected data with participants to ensure what is written is in line with their responses.

3.8.2 Transferability

The ability to apply the findings to different situations is referred to as transferability (Lincoln & Guba, 1989). Because a full explanation of the settings and the environment in which the study has been done was provided, a qualitative study has assisted with meeting the criterion of transferability (Maxwell, 2021).

Only two Technology teachers teaching learners with special needs was used as a sample within the Capricorn District. Based on the teachers who teach learners with special needs, the findings may be shared amongst the teachers on how to creatively teach such learners.

3.8.3 Dependability

The term "dependability" refers to the consistency of research findings across time (Janis, 2022; Patterson, Ball, Corkish & Whittick, 2022). It can be established by gathering data on the same study subject using various data collection methods and at various dates (Sinković, Currie, & Bevanda, 2011). Dependability was achieved in this study by engaging participants in a sustained and focused discussion about the study and utilising the same data collection devices to eliminate subjectivity.

3.8.4 Confirmability

If the results can be linked to the data, confirmability can be established. Maxwell (2021) defines confirmability as an aspect that refers to the objectivity of research during data collection and data analysis. Confirmability was achieved in this work by providing participants the opportunity to view the research report to provide confirmations and views on responses from interviews.

3.9 ETHICAL CONSIDERATIONS

Ethical clearance was sought from the Turfloop Research and Ethics Committee (TREC) after which permission was sought in accordance with acceptable ethical procedures.

3.9.1 Permission to conduct the study

The Limpopo Department of Education was contacted for permission to undertake the research.

3.9.2 Informed consent

Informed consent is a technique in which the study participants are provided with crucial details about the study, including the risks and the benefits, before deciding whether to participate (Nnebue, 2010).

Informed consent was properly explained to the participants, who were the Grade 9 Technology teachers comprising of learners with special needs. They were asked to fill in consent forms that I obtained from the University of Limpopo's postgraduate guide. I made sure that the participants understood the research's rationale as well as its goals and objectives. The participants were reminded of their right to withdraw from the study at any time.

3.9.3 Voluntary participation

There was no coercion used to get volunteers to participate in the research (Chivanga, 2016). The participants were allowed to consent and then later change their mind if they wanted to, with no questions being asked. The participants needed to understand their role and the nature of the study, and they were fully aware of what the research entailed. At no point did I lie or deceive participants under any circumstances (Babbie, 2016).

3.9.4 Anonymity and confidentiality

Confidentiality was ensured as I informed the participants that their names would not appear in the research reports. I used alphabetical code names to safeguard the respondents' identity. The specific sub-district where the study took place was also not divulged, may automatically or subconsciously expose the participants under concern and this may be an ethical error. The data in this study were only used for the purpose of the study.

3.9.5 Benefits

The purpose of this study was solely for developing the Technology teachers that teach Mechanical Systems and Control to special needs learners. There were no financial benefits. This research can help the Technology teachers to be informed of the creative strategies that they can employ to teach learners with special needs.

3.9.6 Adherences to Covid-19 protocol

As data gathering took place during Covid-19.I ensured that I adhered to the Covid-19 protocol at the schools by asking for permission to enter the schools and complying with the hygiene and safety measures extracted from the published Gazette 45877 of 6 February 2022. I ensured that I followed and respected Covid-19 protocols by wearing a face mask throughout the entire data collection procedure.

3.10 SUMMARY OF THE CHAPTER

In this chapter the research methodology was examined, providing details about the research approach, the research design, the population size, the sample, the data collection instruments, the validation of the research instruments and the research and data gathering processes. Data analysis was discussed, and the trustworthiness of the study was established. Attention was drawn to ethical considerations.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The previous chapter discussed the research design and methodology that guided this study. The chapter also explained why the qualitative research approach and case study design were adopted.

This present chapter reports the findings and results of the study. The findings were obtained from the non-participant observations and semi-structured interviews. The chapter begins by presenting teachers' biographical profiles to comprehend the teachers' characteristics based on their education, teaching experience, and the number of years they have spent teaching learners with special needs. After that, data pertaining to the research questions are presented and discussed.

4.2 BIOGRAPHICAL DATA OF TECHNOLOGY TEACHERS

In the section below, I present the profiles of the Technology teachers who participated in this study. These data profiles include teachers' professional qualifications, experience in teaching and number of years these teachers have been engaged in teaching learners with special needs.

Given that Limpopo province, especially Capricorn district, does not have many schools with a focus on learners with special needs, a total of two teachers participated in the study. Whilst this may be seen as a small sample, it fits the purpose of the study within the context of special needs. Pseudonyms (A and B) were assigned to the participants to protect their identity and ensure confidentiality.

Table 4.1: ***Summary of Technology teachers' profiles***

Teacher	Gender	Teaching qualifications	Teaching experience	Number of years teaching learners with special needs
Teacher A	Male	Secondary Teachers Diploma – STD (Technical), Advanced Certificate in Education – ACE (Bricklaying and Plastering, Mathematics) Special needs education – SNE	7 years	3 years
Teacher B	Female	Bachelor's degree (engineering) Postgraduate Certificate in Education – PGCE, in Math, Science and Technology	4 years	2 years

Source: Author

With reference to the above information, the table is to be interpreted in the following way:

4.2.1 Biographical data: Teacher A

Teacher A is a male with seven years of teaching experience made up of four years in a regular public school, and three years in a special school. He holds STD (Technical), ACE and SNE qualification. Apart from teaching Technology senior phase, he also taught woodwork, welding, mathematics, and languages. He has attended developmental workshops organised by the Department of Basic Education at provincial level, focusing on training teachers on Technology content.

4.2.2 Biographical data: Teacher B

Teacher B is a female with three years of experience teaching in a special school. She holds a bachelor's degree in engineering then obtained a PGCE in Math, Science and Technology. She has taught civil drawing from Grade 10 to 12 at a high school and was currently focusing on teaching Technology from Grade 8 to 9. She has attended several workshops organised by the Department of Education focused on inclusive education.

Beyond their qualifications, this study unpacks how their qualifications and knowledge about learners with special needs contributes to their enactment of creative teaching strategies. In a highly cited study by Stahnke and Blömeke (2021) it was shown that teachers' qualifications, knowledge of classroom management (including seating arrangements) and

their pedagogical expertise are some of the leading factors that influence teachers' creative teaching strategies to learners with special needs, as discussed in the section below.

4.3 FACTORS INFLUENCING TECHNOLOGY TEACHERS' CREATIVE TEACHING STRATEGIES.

As per the advice from the Organisation for Economic Co-operation and Development (OECD) (2009), teacher qualifications, and knowledge of teaching learners with special needs should be seen as key contributors in assisting teachers to exercise their creative strategies when teaching any instructional concept. Thus, below, this study unpacks how each of the key contributors influence teachers' teaching strategies for teaching Mechanical Systems and Control concepts.

Teacher qualification, and

Knowledge of teaching learners with special needs

The section below discusses these contributors:

4.3.1 Teacher qualification

A qualified teacher is a crucial component of the educational ecosystem (Mlachila & Moeletsi, 2019). A four-year Bachelor of Education degree (B.Ed), a three- or four-year Bachelor's degree, and a one-year Postgraduate Certificate in Education (PGCE) are the most acceptable qualifications for someone to be considered qualified to teach in South Africa. All teachers need to register with the South African Council of Educators (SACE). If one is not registered, it is likely that they cannot be employed legally as a teacher. Thus, it is essential for a teacher to obtain qualifications and register with SACE for competency and employment purposes.

Teaching qualifications prepare teachers to acquire knowledge, skills and training, focusing on upgrading the subject knowledge and teaching skills. A study by Osamwonyi (2016) indicates that it is preferable to have a trained instructor over an incompetent one. Teachers with correct professional qualifications can provide a wide range of learning strategies and tactics—especially to learners with special needs. This can entail engaging the learner directly, letting them participate in their own learning, or asking them to work collaboratively.

Teachers who are qualified to teach a specific subject have procedural knowledge of using resources necessary for the content delivery. For a subject such as Technology, it is essential

that it is taught by a technology specialist since it demands the knowledge, skills and use of various tools and materials for completion of practical assessment tasks, among others.

A qualified special education teacher can work with learners who have mental and physical disabilities as well as speech and hearing impairments, learning disorders, blindness, deafness, weak-sightedness, epilepsy, are hard of hearing, and other disabilities. Such teachers are trained to acquire skills to fulfil the need for specialised instruction. Moreover, they are taught to be able to use tools and methods that have been developed especially for special needs learners. Nevertheless, the following segment unpack in detail the leading factors influencing Technology Teachers' creative teaching strategies. Thereafter, the presentation and the findings will be displayed.

4.3.2 Teaching learners with special needs

The No Child Left behind Act of 2001 calls for teachers to be highly competent and to stress content knowledge and deliver it to the best of their abilities, especially to learners with special needs (Hussey, Thomas, Anderson & Algozzine, 2019). Hence, there is a need for teachers to be equipped and trained to teach learners with special needs. According to Doyle (2020), the aim of teaching learners with special needs is to ensure their integration into society by offering equitable and efficient educational services in special education schools and through inclusive education.

Learners with special needs, among others, are learners with visual impairment, hearing impairment, mental retardation, physical impairment, disability of sound and tone, learning difficulties, behavioural disorders, and learners with health problems (Darling-Hammond, 2021). To meet the educational needs of learners and ensure their success in academics, behaviour socialisation, and emotional development, it is crucial that teachers acquire the necessary training, qualifications, and expertise in teaching learners with special needs (Alea, Fabrea, Roldan & Farooqi, 2020).

The Technology subject was established on interdisciplinarity and has overlaps with many different fields of study (Mathematics, Science, Engineering, Design, and so forth). Schools have been assigning teachers to teach technology for a while now without verifying their professional background in the subject's instruction (Code, Ralph & Forde, 2020). Technology is a practical subject entailing hands-on skills and knowledge and needs the relevant resources and tools to be available so that the subject can be taught properly

(Magolego, Mtshali & Ramaligela, 2022). Thus, it is essential for the Education Department to provide sufficient resources and materials to enable successful teaching and learning.

Training in practical skills and knowledge of how to use those materials and resources are also crucial. In addition, more training is needed for teaching and using technology with learners who have special needs, especially those who struggle intellectually.

Given the nature and focus of this study, it is important to unpack the classroom contexts in which data were collected. This is important because there are certain expectations such as seating plan, visual aids and environmental triggers that are necessary to teach in a classroom with learners of special needs (Cooc, 2019).

4.3.2.1 Classroom description of Teacher A

Figure 4.1. **Teacher A's classroom resemblance**

As can be seen in Figure 4.1, Teacher A's class caters for 11 learners which were basically boys. The classroom consisted of learners with behavioural disorder, intellectual difficulty and autism.

The classroom was relatively large, constructed in a form of a workshop, where windows are high, wide and allow ventilation. The class also had bright lights, artefacts of hydraulics, engines and machinery. Around the class visuals were posted, namely, classroom rules, timetable, charts of mathematical operations, graphs and labelled images of tools.

4.3.2.2 Classroom description of Teacher B

***Figure 4.2* Teacher B's classroom resemblance**

Teacher B's class consisted of 15 learners, of which 9 were girls and 6 were boys. The classroom represented a well organised learning environment with single desks neatly arranged in rows, as viewed from the position where the teacher was situated. The class

consisted of learners who had behavioural disorder, speech language impairment (stammering), intellectual difficulties, and autism.

A whiteboard, projector and learners laptops were available. Also a teacher's table with a box of markers at the back of the class. There was sufficient room for the teacher to move around. Visuals such as the daily schedule, vivid colourful pictures of rules and regulations were posted. The classroom consisted of cupboards serving as storage for learners' books. It also had a kitchen sink at the back of the class.

Having determined the factors that influenced the participants in their employment of creative teaching strategies, the following segment unpacks the data and associated discussions.

4.4 PRESENTATION OF DATA AND DISCUSSIONS: RESEARCH QUESTIONS

4.4.1 Research Question One (How do Technology teachers creatively teach Mechanical Systems and Control to learners with special needs?)

This question was primarily answered by using data from the non-participant observations and complemented by semi-structured interviews. Analysis of the data showed that Technology teachers creatively teach learners with special needs through:

The use of digital resources
Narrative discourses
Textbooks
Artefacts/ models

The above themes are elaborated upon below:

4.4.1.1 The use of digital resources in a special education classroom.

The use of digital resources in schools is increasing as a vehicle to deliver educational knowledge and skills in new and innovative ways (Mtshali, Ramaligela & Makgato, 2020). In these modern times, the need for the development of technology teachers in the use of digital resources as a means of bridging the knowledge gap in teaching learners with special needs must be trumpeted. Also, the South African constitution supports this by stating that everyone has a fundamental right to education, including higher education this includes those with special needs.

The current educational standards emphasise that opportunities should be given to special needs learners so they can reach their full potential. They should not experience

discrimination but should be allowed to engage in education and training on the same terms as learners without impairments.

Henceforth, special education teachers must thrive to accommodate learners with special needs by integrating education with digital resources. When Teachers A and B were asked how they creatively teach Mechanical Systems and Control to learners with special needs, both emphasised the use of digital resources to engage and promote active learning. Teacher A also mentioned that there are various strategies to engage learners either through group discussions or activities.

During classroom observations, Teacher A integrated teaching and learning with the use of digital resources (Refer to Figures 4.3 and 4.4 below).

Teacher A was observed to present the lesson as follows:

Figure 4.3. **Teacher A presenting a lesson using digital projector.**

Figure 4.4. **Teacher A presenting a lesson using laptop**

As shown in Figures 4.5 and 4.6, Teacher A made use of a digital projector and a laptop to show learners animation related to the concept of rotation of gears within the topic of gear systems. To set up the digital resources for the lesson, Teacher A was observed to be assisted by his senior, recognised as the Head of Department (HOD) of Mathematics, Science and Technology. Teacher A greeted the class and went straight to the concept of gears. He asked the class to explain their understanding of gears.

Teacher A: *Anyone who can tell me what is a gear?*

I observed that learners seemed to be confused, trying to figure out what the teacher was referring to as a gear. They began to communicate amongst each other, becoming noisy. Then the teacher switched on the digital projector (Figure 4.5) to display content of Mechanical Systems and Control gear systems, specifically, the rotation of gears clockwise and anticlockwise. An animation was portrayed while the teacher began to provide an explanation. Most learners were engaged, focused on what was displayed but a few were shortsighted and could not clearly see what was projected.

While proceeding with the presentation, the teacher was also asking questions, pointing on the screen.

"Look on the screen, what do you see? What is happening?" Teacher A asked learners.

A learner responded*, "I see wheels Sir, moving around."*

The teacher proceeded with the lesson by explaining the rotation of gears, also elaborating on equal and unequal size counter rotating. A learner asked the teacher how three or more gears could also rotate clockwise and/or anticlockwise. The learner further asked out of the three gears, which one would rotate clockwise and/or anticlockwise.

The teacher responded, saying, *"Gears can either rotate clockwise or anticlockwise."* The teacher's response seemed to not be satisfactory to the learner as the learner insisted on asking another question. However, the teacher ignored the learner by proceeding with the lesson.

By observation, this could indicate that the teacher does not have sufficient knowledge of the content as the response was not satisfactory to the learner and the teacher did not ensure that the learner understood the response. According to Gess-Newsome et al., (2019), a teacher can demonstrate that they have a thorough mastery of a subject when they can respond to any inquiries that are put forth.

I observed most learners were engaged throughout the lesson although a learner with autism seemed to have lost interest before the video was complete. However, the teacher insisted on repeating the video for other learners to watch again.

Teacher B's lesson unfolded as follows:

Figure 4.5. **Teacher B lesson of learners using laptops.**

Teacher B greeted the learners while issuing laptops to all learners. She then instructed learners to switch on their laptops to access a program that she had prepared. Teacher B introduced the lesson by using an activity accessed on learners' laptops. The activity consisted of the use of gears in real-life situations. The lesson focus was on mechanical control systems. She followed by asking learners to explain what they saw on their screens.

The learners responded haphazardly while being noisy. Teacher B instructed learners to raise their hands before responding. One learner, amongst others, responded that she could see a bicycle, another responded, *"a car"*.

Teacher B then explained the concept of mechanical systems using the pictures portrayed on learners' screens. She explained gear systems as wheels with wedges for teeth, emphasising the application of gears in real-life situations. She made use of a program on laptops and instructing learners on how to operate and access the activity prepared for them.

The activity accessed on the learners' laptops was an animation of a car speeding and braking between two tanks, as shown in Figure 4.5. The teacher used the animation to teach about different mechanical control systems such as a car disc braking system. However, an intellectual difficulty learner was slow to comprehend and follow the instruction from the teacher, resulting in incomplete work by the learner.

"To engage my learners, at times I use laptop and projector to play videos of how tools are used and for what purpose." - Teacher A (interview)

"I use a laptop sometimes, or pictures from the internet to provide learners with the image of what I am teaching about." - Teacher B (interview)

Participants indicated that at times they made use of the digital resources for teaching and learning. However, having to adapt to learners with special needs was very difficult as most of them have not been exposed to educational digital resources (Azoulay, 2020). Teacher B further indicated that "*it requires more responsibility to manage the devices, this is due to comprising of special needs specifically the behavioural disorder learners"* -Teacher B (interview).

Participants were asked if they could use the digital resources independently. The participants responded that they some knowledge of using digital resources, although they still needed assistance by colleagues to set up for the lesson.

It can be said that the participants have knowledge of how to use educational devices as both of them succeeded in making use of digital resources. According to a study by Rozinah and Meiriki (2020), the desire to learn digital literacy can motivate teachers to use digital tools and the internet to find information more effectively and efficiently. The use of technological resources demonstrates that teachers are computer and information literate as well as digitally literate.

4.4.1.2 Narrative discourses

The basis of narrative learning is the idea that connecting new knowledge to real-world experience and integrating it into existing stories of meaning are effective ways to communicate educational concepts (Lindner & Schwab, 2020). Both participants frequently discussed how stories and narratives enhance comprehension and aid learners in making sense of the subject matter.

According to Szurmak and Thuna (2013), employing narratives necessitates that a teacher possesses significant subject-matter expertise to be able to develop tales that are pertinent to the lesson's objectives. In another lesson, in addition to making use of the overhead projector, Teacher A made use of a story to explain the concept of clockwise and anti-clockwise movement of gears. An example was of a neighbour driving from work to home, making use of a remote-control access device which prompts the gate to open and then close as he enters his home.

The opening of the gate was interpreted as clockwise movement and the closing of the gate as anticlockwise movement of gears. While teaching and learning was taking place, an intellectual difficulty learner began to interject, adding comments to the teacher’s narrative about the remote-control gate. The learner needed to understand more about the remote-control gate and asked if the gate would open without the remote.

The question raised arguments amongst learners with some learners responding that the gate would only open with the remote, while the intellectual difficulty learner argued that it could even get opened manually. The teacher intervened with a response that the gate could only open with a remote device, elaborating that this is because the gate consists of a motor kit. Learners further asked what a motor kit is.

The teacher tried to explain to the learner what a motor kit is, though the learner seemed to remain confused.

Teacher B made use of a story to explain the concept of driver gear and driven gear. The example was about a 7-year-old son who got a bus to a township with his mother. *"Normally there are a lot of people and stores in a mall. For the mother not to lose his son what can she do?"* Teacher B asked learners.

Learners gave various responses, although one gave a response satisfactory to the teacher *"The mother can hold his child with a hand."* The teacher asked a follow-up question, *"Is it the child who is supposed to hold the mother's hand, or is it the mother who is supposed to hold the child's hand?"* Most of the learners indicated that the mother is the one who is supposed to hold the child's hand. So, the teacher indicated that since the mother is the one who is supposed to hold the child's hand then the mother is regarded as the driver gear, the child is regarded as the driven gear.

Participants indicated that though at times they make use of narratives, they pointed out that it is not always that learners understand and are able to follow through the narratives.

"*I have used stories to explain some concepts within the content. Example, explaining braking failure of a car, but my autism learner is the one who struggles to understand the stories."* - Teacher A (interview).

"At times I make use of narratives to provide learners with examples of the topic of the day, to engage them. But sometimes it's not all of them who are able to relate with the stories, while others even remain confused." - Teacher B (interview)

Participants were asked which learners particularly are likely to not follow through the narratives and they responded as follows:

"In most cases it is (mentioned name of a learner) who is diagnosed with autism, he is the one who is likely to not follow through the narratives." - Teacher A (interview)

"A few of my learners (indicated by pointing them out during lesson) are the ones who at times do not follow, they are likely to remain confused." – Teacher B (interview)

Responses of participants indicated that it is beneficial to teach using narratives to learners with special needs. This was affirmed by Bello's (2020) study which indicated that teaching using narratives allows learners to construct their own meaning from evaluating the reality that surrounds them and produce their own interpretation of it.

Again, the potential of narratives to contextualise content to educational experiences supports learners' diversity, boosts learners' self-esteem, and improves their social and psychological skills.

4.4.1.3 Textbooks

Figure 4.6. **Teacher B's textbook**

Figure 4.7. **Teacher A's textbook**

Textbooks are still considered the most authoritative source of information by teachers in schools. According to Mathabatha et al. (2022), this is because a number of technology teachers still do not understand the subject matter and how to teach it. Moila, Mji and Mnisi (2020) attest that the recruitment process for most technology teachers in schools is that of filling a teacher's workload rather than looking at their competency to teach technology. Figures 4.8 and 4.9 show technology textbooks that are used by teachers in schools.

These are some of the textbooks that are recommended by the Department of Education for senior phase Technology subjects. Due to its role as the main curriculum bearer, the textbook plays a vital role in both the teaching and learning of academic subjects (Wininger, Redifer, Norman & Ryle, 2019).

Consequently, it may be argued that textbooks greatly affect learners' abilities to accomplish the curriculum's objectives (Wininger et al., 2019). Textbooks continue to be the main educational resource utilised to support the mandated curriculum, claim Wininger et al., (2019). Both participants utilised at least one of the Grade 9 technology textbooks.

Teacher A used the *Spot-On Grade 9* Technology textbook, while Teacher B made use of the *Platinum Grade 9* textbook. However, both teachers declared that they seldom ever utilised them for instruction and learning but rather for preparation of lessons.

***Figure 4.8*. Guide used by Teacher A**

In addition, Teacher A made use of a guide shown in Figure 4.10 which summarises chapters within mechanics and various activities. Teacher A stated that each learner is only provided with the guide once there is an activity to complete.

The guides are kept in the storeroom and learners are not allowed to take them home. *"Learners are not provided with the guides or books to take home, for they mostly lose them. Thus, it cost the school to always must prepare guides and order textbooks for learners more than once. Their books are stored in the cupboards."* - Teacher A (interview)

Teacher B's class often make use of a textbook and worksheets downloaded from the internet. *"I don't provide learners with homework; they don't normally complete them. Due to most parents are not engaged, actively participating in the learners' progress of schoolwork."* - Teacher B (interview)

4.4.1.4 Artefacts

Technology artefacts are physical items having intended uses. Anything a teacher utilises to convey aspects of practice is regarded as an artefact. According to Kallick and Zmuda (2017), when learners handle an artefact, they are using their senses, growing their ability to ask and answer questions, strengthening their knowledge of a time period, and developing empathy for individuals from the past.

A study by Nortvig, Petersen, Helsinghof and Brænder (2020) outlined that active learning is achieved when teachers use artefacts during teaching. The use of artefacts allows learners to become curious about peculiar items. Learners become eager to handle, touch or manage the artefacts exposed to them. When used successfully for instruction, artefacts can have an impact on both learning and behaviour.

Figure 4.9. **Teacher A lesson of learner using hydraulic jack.**

Figure 4.10. **Teacher A lesson of learner assembling disc brake plate**

Teacher A used a hydraulic jack as an artefact, as seen in Figure 4.11, to describe and expound on the function of the hydraulic system. Teacher A had a whole class discussion about ways in which a mechanic can lift an engine for service purposes. He further explained to learners (omit outlining) ancient ways in which cars or engines could be lifted. He also engaged learners in ways in which a hydraulic system functions, mostly to lift heavy machines. A learner went to test the use of a hydraulic jack to elevate an engine to see how it worked.

As seen in Figure 4.12, Teacher A used a braking disc to describe the components of a car's braking system. He explained and elaborated on the process of how the braking system brings a car to a stop. He engaged learners through a step-by-step demonstration of the braking system, while instructing a learner to assemble the artefact.

Teacher B instead was guiding learners on how to make a man-made (hand-made) artefact.

Figure 4.11. **Teacher B lesson of learner designing women hat**

Though the artefact was not relevant to Mechanical Systems and Control, this serves as proof that the teacher has knowledge of the use of artefacts. As shown in Figure 4.13, a learner was making an artificial fascinator hat for a woman. The learner was making use of Mannequin Head Plastic and a hat board to form this fascinator hat.

4.4.2 Summary of the PCK of participants from lesson observations

This section concludes research question one by discussing the findings according to the themes which emerged from the theoretical framework. The findings are presented according to four themes namely: content knowledge, pedagogical content knowledge, educational context and knowledge of learners and their characteristics.

Content knowledge

The findings displayed participants having inadequate knowledge of the subject matter as participants could not respond to possible questions raised by learners. Moreover, participants relied more on textbooks for content knowledge.

Pedagogical content knowledge

Participants demonstrated that they have insufficient pedagogical content knowledge. Though participants employed the use of narratives to teach the content, the scenarios were not familiar to learners. Some learners would get lost along the way, as the teacher continued to narrate. As a result, learners would miss what was set to be learned during that lesson.

Again, though teachers would use artefacts for delivery of the content, not all learners would be actively involved.

Educational context

While the participants made use of digital resources during teaching, both participants still needed assistance on the operation of the resources from others. Teachers may not be regarded as having sufficient knowledge of the use of educational devices as participants have not gone beyond the use of the laptop and projector.

Knowledge of learners and their characteristics

The participants' classes consisted of learners with autism, intellectual difficulties and behavioural disorder and were regarded as special needs learners. Participants demonstrated insufficient knowledge of learners and their characteristics as teachers failed to engage learners throughout the lessons.

Teacher A, for instance, continued to replay the animation (video) whilst not realising that an autistic learner was already bored. Teacher B also failed to take through an intellectual difficulty learner during a lesson when using laptops.

4.4.3 Research Question Two (What are the pedagogical challenges encountered by the teachers when teaching learners with special needs?)

This question was primarily answered by using data from the semi-structured interviews.

When I was analysing data from the semi-structured interviews, I discovered that teachers encounter the following challenges:

Lesson preparation
Utilizing learners' existing ideas and prior knowledge
Challenges to fulfil Curriculum objectives.

The above themes are elaborated upon below:

4.4.3.1 Lesson planning

A lesson plan is a teacher's thorough outline of the content and 'learning trajectory' for a particular lesson. It is important that a teacher creates a daily lesson plan to direct instruction for learners. According to VanTassel-Baska and Baska (2021), lesson preparation is essential because it connects the goals of the curriculum with the regular teaching and learning that takes place in a classroom, regardless of the amount of detail. Teachers use lesson plans for comprehensive guidelines as they teach curriculum.

Participants were asked about their lesson preparation, outlining if the lesson plans were fulfilled as planned. The responses are as follows:

"Immediately after school for about 20-30 minutes I prepare tools for practical to be completed the following day. It is easier for me to prepare for practicals, though challenging for content delivery. The lessons never unfold as prepared." - Teacher A (interview)

"I prepare my lessons first thing in the morning with a fresh mind, reflecting on the previous day lesson. It is not all the time that the lessons unfold as prepared." - Teacher B (interview)

Responses of participants show that participants have knowledge of the importance of preparing a lesson though they have indicated the inability to follow through to fulfil a lesson as planned.

The ability to successfully plan lessons for class and workshops is a requirement for special education teachers. According to Brittin (2016), making lesson plans demonstrates that a special needs teacher has a firm grasp of the concepts covered in the technology curriculum. Teachers can accomplish objectives, such as improving learners' competencies, through lesson planning.

4.4.3.2 Challenges to fulfilling curriculum objectives.

The curriculum assessment policy indicates that it is compulsory to cover the given scope each term (DBE, 2011). Thus, teachers must ensure content coverage with the learners during each term. As classrooms comprise various learners with special needs, teachers are faced with employing different strategies to accommodate all learners with various needs.

The excerpts below show teachers' barriers to content coverage.

"Content coverage is a challenge as some learners takes time to grasp content taught during a particular period and also absenteeism." - Teacher A (interview)

"At times it is a challenge to cover everything due to some learners being forgetful, so one needs to do a recap on what was being taught the previous day, for which that accumulates time." - Teacher B (interview)

Teachers A and B showed that they have a challenge with having to cover the scope required within a term. Bailey, Hastings and Totsika (2021) also indicated that learners with intellectual difficulties are likely to have retention problems. It is challenging for teachers to have to re-teach or find ways which can help these types of learners to also be able to progress in their academic work.

4.4.3.3 Utilising learners' existing ideas and prior knowledge

Prior knowledge is the knowledge one possesses prior to learning new ideas or concepts. They may have accumulated this knowledge through their personal, societal, and cultural influences (Dong, Jong, & King, 2020).

It is important that teachers prompt learners' prior knowledge before introducing content knowledge. Participants were asked about ways in which they prompt learners' prior knowledge, and they responded in the following way:

"I ask learners questions before teaching, mostly verbally to find out what they already know. Although it is not all the time that I manage to find what they already know due to some being playful." - Teacher A

"I use pictures from the internet related to the topic that I am about to teach, then ask learners questions and engage in discussion." - Teacher B

In reference to the above responses, teachers stated that they ask learners questions or display pictures to enact their learner prior knowledge. According to Howze-Owens (2021), teachers can be dynamic in assessing learners' prior knowledge by using audio visual resources, verbal questions and narrating past experience in order to evoke their thought process. This was the case with these two teachers. In fact, prior knowledge is a key element that teachers must consider when creating and modifying their class plans (Nambiar, 2020).

Again, it is important for teachers to assess whether the acquired prior knowledge is essential or nonessential to the content to be taught. Nambiar (2020) states that teachers should rethink or alter their lesson plans for learners with insufficient prior knowledge so that they can meet their needs and develop their own expertise.

Participants demonstrated knowledge of the importance of prompting learners' prior knowledge. However, there is still a need to improve ways in which prior knowledge can be prompted and accurate knowledge can be found.

4.4.4 Summary of the PCK of participants from the lesson interview

This section concludes research question two by discussing the findings according to the themes which emerged from the theoretical framework. The findings are presented according to three themes, namely: content knowledge, pedagogical content knowledge and knowledge of learners and their characteristics.

Content knowledge

Another instance where participants demonstrated insufficient content knowledge was when participants indicated that they could not plan lessons and follow through effectively.

Pedagogical content knowledge

Participants could not activate their PCK to keep learners engaged in lessons. Teachers also failed to achieve lesson objectives and could not plan proper lessons. This is evident as participants failed to prompt learners' prior knowledge.

Knowledge of learners and their characteristics

Teachers do not have sufficient knowledge of their learners as they fail to complete content due to the inability to retain the attention of the intellectually challenged learner as well as

absenteeism. A teacher with sufficient knowledge of their learners would find and employ various ways to be able to complete the curriculum and achieve lesson objectives.

4.4.5 Research Question Three (How can Technology mini-practical tasks be aligned with pedagogical needs of the learners with special needs)

This question was primarily answered by using data from the semi-structured interviews.

When I was analysing data from the semi-structured interviews, analysis of the data showed that Technology mini-practical tasks can be aligned with pedagogical needs of special needs through:

Administration of Mini-PAT
Engaging learners in the design process (IDMEC)

4.4.5.1 The abovementioned themes are discussed in the following segment: *Administration of Mini-PAT*

The mini-practical assessment task (mini-PAT) is a set of assessment tasks that is designed for different activities with the aim of developing the learners' critical thinking skills. The Curriculum Assessment Task (DBE, 2011) indicates that formal assessment for Technology consists of the mini-practical assessment tasks and pen and paper tests or examinations.

The Curriculum Assessment Task also indicates that at least 40 out of the 70 mini-PAT marks per term must be attributed to practical work. It is compulsory for Technology Grade 9 teachers to administer mini-PATs to learners with special needs.

Participants indicated that they do have time scheduled for practical work. For Teacher A, practical work is scheduled to be twice a week. For Teacher B, practicals are dependent on the lesson preparation.

Teacher A noted: *"Monday and Tuesday are set for teaching, while Wednesday and Thursday are for practical work".* Teacher B explained during her interview that *"after content coverage, that's when I plan and prepare for practical work".*

The above indicates that participants have knowledge of administering formal assessment (mini-PAT) which serves as practical work for learners. Kola (2022) maintains that it is important that Technology teachers understand the content to be taught. Again, planning helps the teachers to set appropriate tasks and provide the learners with well-structured activities.

The hands-on practical tasks are purposed to equip learners with knowledge and skills to be able to produce an outcome such as a model, an artefact, or an ornament (Gumbo, 2020). It is the teacher's responsibility to ensure that their learners acquire the necessary skills while completing the Mini-PAT task. Participants were asked whether they were able to administer the Mini-PAT successfully and their responses are as follows:

"Not really successfully as most of the time the Mini-Pat remains incomplete; reason being some learners lose interest in the process." - Teacher A (interview)

"My learners tend to complete the Mini-PAT but are likely to provide incorrect responses. Then I cannot say I administer the Mini-PAT successfully." - Teacher B (interview)

The excerpts above indicate that special needs teachers are unable to administer mini-PAT successfully, due to learners' incorrect responses and/or loss of interest. It is essential that Technology teachers teaching learners with special needs get trained to administer mini-PAT successfully so that they can ensure that all learners acquire the necessary skills.

Participants indicated that in most cases learners are instructed to complete the tasks in groups rather than individually. They further explained that this is due to lack of educational resources. Though DBE (2011) states that schools must take responsibility for providing resources (both tools and materials) needed during the mini-PAT, schools are failing to do so. This seems to be an ongoing challenge for teachers as Gumbo (2020) also outlined that lack of educational resources, the inadequate training of Technology teachers and overcrowded classes are some of the challenges that hinder the teaching of mini-PAT.

Learners in Teacher A's class were observed completing a practical assessment task. The task was about the use of various measuring tools. Learners were working in groups, and the teacher prepared different measuring tools.

***Figure 4.12*. Teacher A lesson of learner completing Mini-PAT.**

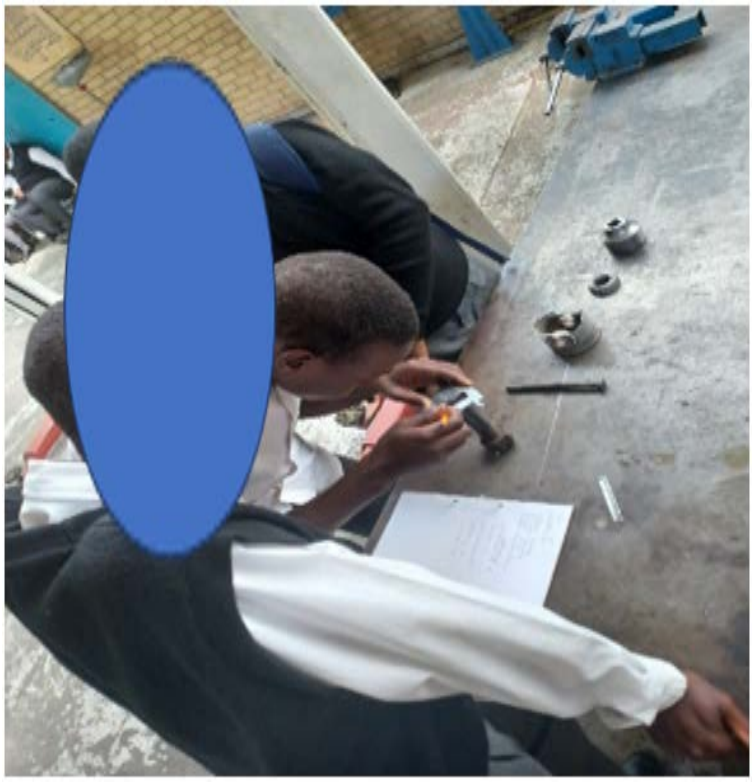


***Figure 4.13.* Teacher A lesson learners completing mini-PAT in groups.**

As shown in Figure 4.12, a learner was using a tape to measure and record the length of the engine stand and in Figure 4.13 learners were using callipers to measure different bolts and record the findings.

Participants indicated that instructing learners to work in groups is not effective for ensuring that all learners acquire the necessary skills while completing the tasks. As shown in Figures 4.12 and 4.13, learners were to acquire the skill of measuring using different tools. Though they were instructed to work as a group, some learners in the group tended to observe and/or wait for a member to complete task. As a result, the skill was acquired by one member of the group rather than all learners within the group.

4.4.5.2 Engaging learners in the design process (IDMEC).

The Mini-PAT task is structured according to the design process, and completing it requires aspects of the design process. According to Reinsfield and Lee (2021), it is important that the teachers engage learners in activities that will use the design process. The first stage of the design process is "investigation". This stage requires that learners should be able to do research, gather data on existing products and compare, observe, interpret and process collected data.

"I take that the investigation stage refers to learners finding out ways of resolving a problem. I ask my learners guiding questions concerning a problem, for them to find ways of resolving that problem." - Teacher A's response

"It means that learners should gather information by using newspapers, internet, books, even from interviewing people. I firstly ensure that all my learners can identify the problem from scenario, then instruct them to go find possible resolutions." - Teacher B's response.

The participants seemed to have a clear understanding of this stage of the design process, though how to ensure that learners acquire the skill is unclear.

The second stage of the design process is "design". Design involves writing a design brief, generating possible solutions, drawing these ideas—which require graphic skills—selecting the best solution; and preparing a working drawing.

"During the design stage, I instruct my learners to write resources that are needed to resolve the problem." - Teacher A

"I tell learners to draft a plan of how they will solve the problem they are faced with, including materials, then draw to show how the product will look like." - Teacher B

Participants have mentioned one or two aspects that need to be followed during this stage. It may be that teachers do not know the assessment standards and skills associated with this stage of the design process.

The third stage is “making”, where learners are provided with an opportunity to use tools, equipment, and materials to develop a solution to the identified problem. Skills such as cutting, joining, shaping, and measuring, among others, are developed and should happen in a safe and healthy environment.

“They mostly work in groups, so while making the product I monitor them to ensure that they don’t hurt one another with tools.” - Teacher A

“I allow learners to work as a team, while guiding them to complete the model.” - Teacher B

Participants focused more on the product rather than the development of skills during the process of making the product. Gumbo (2020) urge teachers not to focus too much on the product but to see the design process as a process of developing skills.

The evaluation stage demands that the learners evaluate actions, decisions, and results throughout the design process.

“I check each group’s progress, then prompt questions to guide them to evaluate their model, whether they are doing right or wrong.” - Teacher A

“I use a checklist with them to assist with evaluation. In most instances specifications and constrains are not considered.” - Teacher B

Participants have indicated that evaluation is used to assess whether the product is being completed correctly or not. Most teachers neglect the fact that evaluation assists with ensuring that the product is made accurately with reference to specifications and constraints. To ensure the product comes out as designed, referring to sketches, also ensures it is genuine.

Again, responses indicated that testing and evaluation must take place against specifications; however, no one mentioned the need to suggest improvement to the product and refer to drawings, which are a part of product development in a real-world situation (Roberts, Allen & Coley, 2020).

The last stage of the design process is Communication, which is described by DBE (2014) as evidence of the process that was followed. All the stages of the design process are filed in a project portfolio. The communication can be done in oral and/or written form.

Participants understand this stage as "*communication allows learners to explain the processes followed when completing the project, learners are assessed on this stage by answering questions regarding the project."* - Teacher A

"I allow each group to present their product in a form of selling to the entire class. This helps my learners to have confidence in what they have made and encourages strong teamwork." - Teacher B

This stage was well described. Participants mentioned communication as a form of presentation of the project which enables learners to work cooperatively with one another. While examining the data provided on the design process phases, teachers do not perceive the wider picture when using the design process to address an issue. Instead, they see each stage as an independent process with no connections between them.

4.4.6 Summary of the PCK of participants from the lesson interview

This section concludes research question three by discussing the findings according to the themes which emerged from the theoretical framework. The findings are presented according to two themes, namely, pedagogical content knowledge, and knowledge of learners and their characteristics.

Pedagogical content knowledge

The Technology subject requires that learner's complete practical tasks. Therefore, Technology teachers are supposed to provide learners with a practical task to complete, as indicated in the CAPS document. Participants in this study have scheduled time for practical's although they fail to administer them successfully.

Knowledge of learners and their characteristics

Participants have indicated they do not have sufficient knowledge of the learners. This was evident as the teachers could not successfully administer Mini-PAT, especially to learners with special needs. Teachers are failing to ensure that all the learners acquire the necessary IDMEC skills. The strategy used by the teachers only enabled a member of the group to be the one to acquire the skills.

4.5 SUMMARY OF THE RESULTS

In this chapter I aimed to answer three research questions posed by this study. The findings of the first research question (How do Technology teachers creatively teach Mechanical Systems and Control to learners with special needs?) revealed that Technology teachers used digital resources (i.e., PowerPoint slides), narrative discourses, textbooks, and artefacts.

Data from semi-structured interviews were used to answer research question two (What are the pedagogical challenges encountered by teachers comprising of learners with special needs?).

The data revealed that teachers comprising of learners with special needs have challenges such as prompting learners' existing ideas and prior knowledge, recognising learners' errors, barriers to fulfilling Curriculum objectives and ensuring engagement of learners throughout the lesson.

Data from semi-structured interviews were used to answer research question three (How can Technology mini-practical tasks be aligned with the pedagogical needs of the learners with special needs). The findings revealed that there are methods teachers can use to align mini-practical tasks with the pedagogical needs of learners with special needs, through the way in which Mini-PAT is administered and by engaging learners in the design process.

4.6 SUMMARY OF THE CHAPTER

In this chapter the results of two case studies were presented. Findings on the two teachers' content knowledge, knowledge of educational context and knowledge of learners and their characteristics were presented. The findings revealed that both teachers have inadequate content knowledge on the topic of Mechanical Systems and Control. They also have insufficient knowledge of instructional strategies and limited knowledge of their special needs learners.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter presented and discussed data using the emergent themes, and analysed and discussed the findings from the non-participant observations and semi-structured interviews. The data were analysed based on the purpose of the study. The summary of findings from each research question was done in line with Shulman's PCK categories which were used as a framework for this study.

This chapter concludes the study by outlining the conclusion that was drawn from the findings, and the limitations that emerged during the whole process of data collection. It also includes the recommendations from the study findings.

5.2 CONCLUSION OF THE STUDY

The purpose of this study was to explore creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special needs. This study used Shulman's (1987) Pedagogical Content Knowledge as a framework that assisted in fulfilling the purpose of the study. The study concludes that the Technology teachers did not have specific creative teaching strategies to teach learners with special needs during all the Mechanical Systems and Control lessons.

This study discovered that Technology teachers' pedagogical content knowledge was highly questionable as they displayed little knowledge about teaching learners with special needs (knowledge of learners and their characteristics). These teachers could not provoke their PCK to keep learners engaged in the lessons as some of them were learners with autism and needed creative strategies from teachers to increase their concentration span.

Nevertheless, when exploring how Technology teachers creatively teach Mechanical Systems and Control to learners with special needs, this study discovered that the Grade 9 Technology teachers failed to use various teaching strategies adequately. Mechanical Systems and Control Teachers used digital resources, narrative discourses, textbooks, and artefacts. However, all these techniques were not used consciously with the aim of ensuring that all learners understood concepts presented to them.

Although teachers had slides, they were learners who were shortsighted and could not clearly see what was projected. Those who had textbooks could not read to understand instructions and even the narrative discourses that the teachers attempted were not familiar to learners' living conditions, thus could not promote active learning.

When exploring the pedagogical challenges encountered by the teachers when teaching learners with special needs, this study discovered that Grade 9 Technology teachers faced various pedagogical challenges, namely, lesson planning, utilising learners' prior knowledge and barriers when trying to fulfil curriculum objectives when teaching learners with special needs.

The findings revealed that teachers did not have lesson plans that indicated creative strategies they were going to use during instruction a serious pedagogical and curriculum knowledge deficiency. With the lack of such planning, it was inevitable that teachers would not be able to assess learners' prior knowledge. Indeed, this study discovered that teachers encountered challenges to entice learners with prior knowledge.

During instruction, this study discovered that teachers rarely used teaching strategies other than the question-and-answer method. This fuelled more confusion for learners as teachers could not ascertain what the learners already knew about Mechanical Systems and Control. Teachers were teaching as if no learner had a special learning need. Actually, at some point, one could forget that the teacher was teaching learners with special needs because there was little learning participation.

When exploring how the Technology mini-practical task could be aligned with the pedagogical needs of learners with special needs, this study determined that there were opportunities that mini-PAT could offer to assist teachers with their pedagogical shortfalls**.** The findings indicated that participants have knowledge of administering formal assessment (mini-PAT) which serves as practical work for learners. The biggest issue could be how to adequately implement it to learners with special needs.

Given these challenges, it was important to come up with recommendations to deal with the issue of employing creative strategies for teaching Mechanical Systems and Control to learner with special needs. These recommendations will be dealt with in the next segment.

5.3 RECOMMENDATIONS OF THE STUDY

Based on the findings of this study, the following recommendations are made to assist teachers of learners with special needs to come up with creative teaching strategies for teaching Mechanical Systems and Control.

Technology teachers have linear understanding about their PCK, therefore urgent training is recommended in the form of Continuous Professional Development

Technology teachers have knowledge about various digital technologies that can be used for instruction; however, they do not have creative methods to keep learners with autism attentive throughout the lesson. It is recommended that teachers have teacher assistants who are experts in different learners' special needs.

Technology teachers are not conscious of the teaching methods they normally use in their classes. Thus, it is recommended that all teachers be trained to use the following methods (see Figure 5.16) which are suitable for teaching learners with special needs.

Below Figure 5.1, each of the strategies are explained so that teachers, policymakers and researchers have an understanding and apply them.

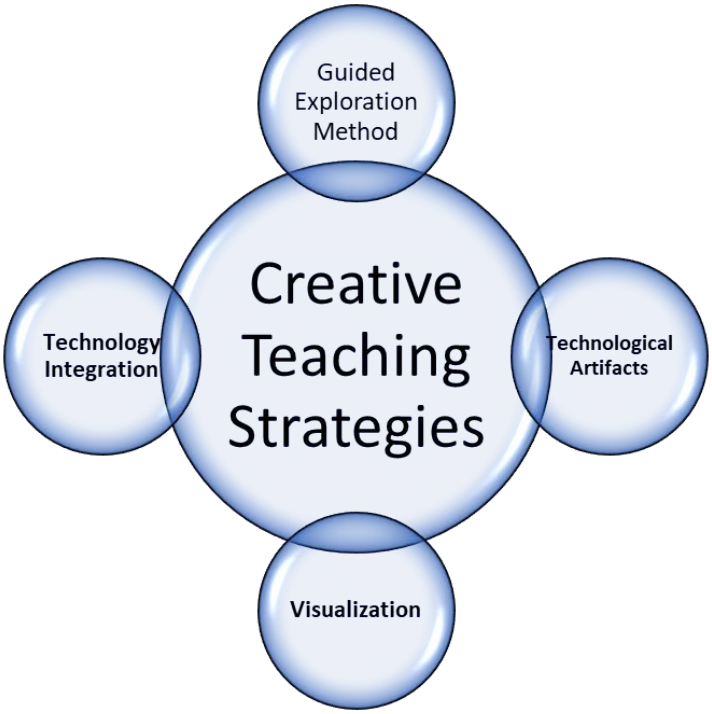


***Figure 5.1*. Creative teaching strategies. Created by the author**

Guided exploration method

The guided exploration method is an approach which allows a teacher to create a series of rationally constructed questions to be given to learners. Each response prompts the next question as the learner progresses through the questions in order. The learner will eventually grasp a specified concept. This approach is effective in engaging diverse learners in Technology concepts.

Technology integration

Technology integration is an approach which allows instant accessibility to information. This includes the use of smartphones, computers, and tablets, which are technological devices that can be used to create meaningful learning experiences.

Utilising different types of technology in the classroom can create learners who are actively engaged with learning. Technology integration also opens doors for individualised education to fulfil each student's specific requirements as an individual learner within a larger classroom environment.

Technological artefacts

Technology artefacts are physical items having intended uses. Nuclear submarines, chairs, and diesel engines are examples of technical artefacts and items having specific uses plans. Teachers can use technological artefacts to equip learners with special needs. The use of this method allows learners to engage their senses, improve their ability to ask and answer questions, and deepen their understanding of particular concepts while touching and/or exploring the artefacts.

Visualisation

Teachers may creatively teach learners using visuals. Teachers may increase learners' engagement, comprehension, and retention of knowledge and concepts in the classroom by using effective visual aids.

The tried and tested technique of using visual assistance posters to convey ideas and information can dramatically improve learning for learners with special needs. These instructional posters may be hung on the walls of a classroom, providing pupils with an easy point of reference, and enhancing the aesthetic appeal of the space.

5.4 LIMITATIONS OF THE STUDY

This study was conducted in one district in Limpopo Province and only two special schools were sampled out of ten schools. This limited me from identifying information from other districts on the creative teaching strategies which may be employed to teach Mechanical Systems and Control to learners with special needs.

Only two teachers were observed and interviewed, thus this cannot be generalised to the whole province. The sample size excluded the voices of most of the teachers. Not all learners with special needs were included in the study, it focused specifically on learners with autism, intellectual difficulties, and behavioural disorder.

6. REFERENCES

Alea, L. A., Fabrea, M. F., Roldan, R. D. A., & Farooqi, A. Z. (2020). Teachers' Covid-19 awareness, distance learning education experiences and perceptions towards institutional readiness and challenges. *International Journal of Learning, Teaching and Educational Research, 19*(6), 127-144.

Allan, G. (2020). Qualitative research. In *Handbook for research students in the social sciences* (pp. 177-189). Routledge.

Asenahabi, B. M. (2019). Basics of research design: A guide to selecting appropriate research design. *International Journal of Contemporary Applied Researches,* 6(5), 76-89.

Asma, N. (2021). Using a smartphone video camera to reduce anxiety in speaking activity. *English Education Journal*, *12*(1), 38-55.

Ayaya, G., Makoelle, T. M., & van der Merwe, M. (2020). Participatory action research: A tool for enhancing inclusive teaching practices among teachers in South African full-service schools. *SAGE Open, 10*(4), 2158244020963576.

Ayaya, G., Makoelle, T. M., & van der Merwe, M. (2021). Developing a framework for inclusion: A case of a full-service school in South Africa. *International Journal of Qualitative Studies in Education*, 1-19.

Babbie, E. (2016). *The practice of social research* (4th ed.). Boston, MA: Cengage Learning.

Bailey, T., Hastings, R. P., & Totsika, V. (2021). COVID-19 impact on psychological outcomes of parents, siblings and children with intellectual disability: Longitudinal before and during lockdown design. *Journal of Intellectual Disability Research*, *65*(5), 397-404.

Banks, F., & Barlex, D. (2020). *Teaching STEM in the secondary school: Helping teachers meet the challenge*. Routledge.

B Basey, J., Sacket, L., & Robinson, N. (2008). Optimal science lab design: Impacts of various components of lab design on students' attitudes toward lab. International Journal for the Scholarship of Teaching and Learning, 2(1), article 15.

Beattie, I. R., & Thiele, M. (2016). Connecting in class? College class size and inequality in academic social capital. The Journal of Higher Education, 87(3), 332-362.

Bello, L. (2020). A qualitative study on teachers' and students' perspectives on the integration of digital storytelling in map reading instruction. Journal of Science, Technology and Mathematics Education, 16(4), 171-179.

Billingsley, B., Israel, M., & Smith, S. (2011). Supporting new special education teachers: How online resources and Web 2.0 technologies can help. Teaching Exceptional Children, 43(5), 20-29.

Bloomfield, J., & Fisher, M. J. (2019). Quantitative research design. Journal of the Australasian Rehabilitation Nurses Association, 22(2), 27-30.

Bos, D., Miller, S., & Bull, E. (2022). Using virtual reality (VR) for teaching and learning in geography: fieldwork, analytical skills, and employability. *Journal of Geography in Higher Education*, *46*(3), 479-488.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101.

Brittin, R. V. (2016). Preservice and experienced teachers' lesson plans for beginning instrumentalists. *Journal of Research in Music Education, 53*(1), 26-39.

Broomhead, K. E. (2013). Preferential treatment or unwanted in mainstream schools? The perceptions of parents and teachers with regards to pupils with special educational needs and challenging behaviour. *Support for Learning, 28*(1), 4-10.

Bruner, J. (1986). Play, thought and language. *Prospects: Quarterly Review of Education*, *16*(1), 77-83.

Bryant, D. P., Bryant, B. R., & Smith, D. D. (2019). *Teaching students with special needs in inclusive classrooms.* Thousand Oaks: Sage.

Bryman, A. (2016). *Social research methods* (5th ed.). London: Oxford University Press.

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice, 2*(14), 1-10.

Chaidi, I., Drigas, A., & Karagiannidis, C. (2021). ICT in special education. *Technium Soc. Sci. J., 23,* 187.

Chivanga, S. Y. (2016). Qualitative research methodology and numbers. *Journal of Social Sciences, 47*(2), 119-122.

Clark, T., Foster, L., Bryman, A., & Sloan, L. (2021). *Bryman's social research methods* (6th ed.). Oxford University Press.

Code, J., Ralph, R., & Forde, K. (2020). Pandemic designs for the future: Perspectives of technology education teachers during COVID-19. Information and Learning Sciences, 121(5/6), 419-431.

Cohen, L., Manion, L., & Morrison, K. (2018). The ethics of educational and social research. In *Research methods in education* (pp. 99-128). New York: Routledge.

Cooc, N. (2019). Teaching students with special needs: International trends in school capacity and the need for teacher professional development. *Teaching and Teacher Education, 83*, 27-41.

Cremin, T. (2015). Perspectives on creative pedagogy: Exploring challenges, possibilities and potential. *Education 3-13, 43*(4), 353-359.

Creswell, J. W. (2013). Steps in conducting a scholarly mixed methods study. *DBER Speaker Series*. 48.

Darling-Hammond, L. (2021). Defining teaching quality around the world. *European Journal of Teacher Education, 44*(3), 295-308.

De Jager, T. (2011). Guidelines to assist the implementation of differentiated learning activities in South African secondary schools. *International Journal of Inclusive Education, 17*(1), 80–84.

Department of Basic Education. (2011). *National Curriculum Statement: Curriculum and Assessment Policy Statement. Senior Phase Grade s 7-9.* Pretoria: Department of Basic Education.

Department of Basic Education. (2014). *Draft policy on screening, identification, assessment and support.* http://www.education. gov.za/

Department of Basic Education. (2014). *South African Sign Home Language. Senior Phase Grade 7–9. Curriculum and Assessment Policy Statement (CAPS).* Pretoria: Department of Basic Education.

Department of Education. (2001). *Education White Paper 6: Special needs education, building an inclusive education and training system.* Government Printers. https://www.vvob.org/ files/publicaties/rsa_education_white_paper_6.pdf

Desyandri, D., Muhammadi, M., Mansurdin, M., & Fahmi, R. (2019). Development of integrated thematic teaching material used discovery learning model in Grade V elementary school. *Jurnal Konseling Dan Pendidikan*, *7*(1), 16-22.

Diken, I. H., Rakap, S., Diken, O., Tomris, G., & Celik, S. (2016). Early childhood inclusion in Turkey. *Infants & Young Children, 29*(3), 231-238.

Dodds, S., & Hess, A. C. (2020). Adapting research methodology during COVID-19: Lessons for transformative service research. *Journal of Service Management*, *32*(2), 203-217.

Dong, A., Jong, M. S. Y., & King, R. B. (2020). How does prior knowledge influence learning engagement? The mediating roles of cognitive load and help-seeking. *Frontiers in psychology*, *11*, 591203.

Doyle, O. (2020). COVID-19: Exacerbating educational inequalities? *Public policy.ie.* Retrieved on 10 June 2020 from http://publicpolicy.ie/papers/COVID-19-exacerbating-educational-inequalities/

Emerson, A. (2016). Applying the least dangerous assumption in regard to behaviour policies and children with special needs. *Pastoral Care in Education 43*(2),104-109.

Engelbrecht, P., Nel, M., Smit, S., & Van Deventer, M. (2016). The idealism of education policies and the realities in schools: The implementation of inclusive education in South Africa. *International Journal of Inclusive Education, 20*(5), 520–535. https://doi.org/10.1080/13603116.2015.1095250

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4.

Fahrman, B., Norström, P., Gumaelius, L., & Skogh, I. B. (2020). Experienced technology teachers' teaching practices. *International Journal of Technology and Design Education, 30*(1), 163-186.

Flannery, W., Healy, N., & Luna, M. (2018). Exclusion and non-participation in Marine Spatial *Planning. Marine Policy, 88, 32-40.*

Florian, L. (2019). On the necessary co-existence of special and inclusive education*. International Journal of Inclusive Education, 23(7-8), 691-704.*

Frederik, I., Sonneveld, W., & de Vries, M. J. (2011). Teaching and learning the nature of technical artifacts. *International Journal of Technology and Design Education, 21,* 277-290.

Gess-Newsome, J., Taylor, J. A., Carlson, J., Gardner, A. L., Wilson, C. D., & Stuhlsatz, M. A. (2019). Teacher pedagogical content knowledge, practice, and student achievement. *International Journal of Science Education, 41*(7), 944-963.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. *The Internet and Higher Education, 19,* 18-26.

Gilmour, A. F., & Wehby, J. H. (2020). The association between teaching students with disabilities and teacher turnover. *Journal of Educational Psychology, 112*(5), 1042.

Given Lisa, M. (2008). Convenience Sample. In *The SAGE Encyclopedia of Qualitative Research Methods.* Thousand Oaks, CA: Sage.

Grossen, S., Grobler, A. A., & Lacante, M. (2017). Repeated retention or dropout? Disputing Hobson's choice in South African township schools. *South African Journal of Education [online], 37*(2), 1-11. http://dx.doi.org/10.15700/saje.v37n2a1367

Guise, A., Witzel, T. C., Mandal, S., Sabin, C., Rhodes, T., Nardone, A., & Harris, M. (2018). A qualitative assessment of the acceptability of hepatitis C remote self- testing and self-sampling amongst people who use drugs in London, UK. *BMCinfectious diseases, 18*(1), 1-8.

Gumbo, M. T. (2020). Professional development of technology teachers: Does their training meet their needs?. *Perspectives in Education*, *38*(1), 58-71.

Gundumogula, M. (2020). Importance of focus groups in qualitative research. *The International Journal of Humanities & Social Studies, 8*(11).

Hanafi, H. (2016). The effect of discovery learning method application on increasing students' listening outcome and social attitude. *Dinamika Ilmu, 16*(2), 291-306.

Hlope, N. E, & Ramrathun, L. (2020). *An exploration of teachers experiences of teaching*

special needs learners in pre-vocational school. (Masters dissertation, University of KwaZulu Natal, Durban).

Hoang, T., & Wyatt, M. (2021). Exploring the self-efficacy beliefs of Vietnamese pre-service teachers of English as a foreign language. *System*, *96*, 102422.

Howze-Owens, J. (2021). *Teaching presence & audio/video-based feedback: Online faculty development for multimodal approaches to teaching.* (Doctoral dissertation, The Chicago School of Professional Psychology).

Husband, G. (2020). Ethical data collection and recognizing the impact of semi-structured interviews on research respondents. *Education Sciences, 10*(8), 206.

Hussey, W. J., Thomas, S. H., Anderson, K., & Algozzine, B. (2019). A survey of responsibilities, workload, and satisfaction of administrators of special education. *Journal of Special Education Leadership, 32*(2).

Janis, I. (2022). Strategies for establishing dependability between two qualitative intrinsic case studies: A reflexive thematic analysis. *Field Methods*, *34*(3), 240-255.

Kallick, B., & Zmuda, A. (2017). *Students at the center: Personalized learning with habits of mind.* ASCD.

Kekana, E. K., Mtshali, T. I., & Ramaligela, M. S. (2023). Inventive Ways of Teaching Mechanical Systems and Control to Grade 9 Learners with Special Learning Needs. *Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika.*

Kem, D. (2022). Personalised and adaptive learning: Emerging learning platforms in the era of digital and smart learning*. International Journal of Social Science and Human Research, 5(2), 385-391.*

Kitto, S. C., Chesters, J., & Grbich, C. (2008). Quality in qualitative research. *Medical Journal of Australia, 188*(4), 243-246.

Kola, I. M. (2022). Using analytical rubrics to assess technological solutions in the technology classroom. *International Journal of Technology and Design Education, 32*(2), 883-904.

Kontostavlou, E. Z., & Drigas, A. (2021). How metacognition supports giftedness in leadership: A review of contemporary literature. International *Journal of Advanced Corporate Learning, 14*(2), 4.

Lewin, K. (1951). Field theory in social science: selected theoretical papers (Edited by Dorwin Cartwright.).

Li, X., Muñiz, M., Chun, K., Tai, J., Guerra, F., & York, D. M. (2022). Inquiry-based activities and games that engage students in learning atomic orbitals. *Journal of Chemical Education, 99*(5), 2175-2181.

Li, Y., Garza, V., Keicher, A., & Popov, V. (2019). Predicting high school teacher use of technology: Pedagogical beliefs, technological beliefs and attitudes, and teacher training. *Technology, Knowledge and Learning*, *24*, 501-518.

Liang, Y. D., Bethely, J., & Walia, G. S. (2021). Visualizing recursion using code and stack animation. *Journal of Computing Sciences in Colleges, 37*(4), 41-49.

Lincoln, Y. S., & Guba, E. G. (1989). Ethics: The failure of positivist science. *The Review of Higher Education, 12*(3), 221-240.

Lindner, K. T., & Schwab, S. (2020). Differentiation and individualisation in inclusive education: A systematic review and narrative synthesis. *International Journal of Inclusive Education,* 1-21.

Luque-Vega, L. F., Lopez-Neri, E., Santoyo, A., Ruiz-Duarte, J., & Farrera-Vazquez, N. (2019). Educational methodology based on active learning for mechatronics engineering students: Towards educational mechatronics. *Computación y Sistemas, 23*(2), 325-333.

Magolego, M. P., Mtshali, T. I., & Ramaligela, M. S. (2022). Nurturing creativity as the 21st century skill: Effective strategies for promoting creativity in the Technology classroom. *Neuro-Quantology, 20*(19) 2921-2931.

Makgato, M. (2014). The challenges of teaching and learning Technology subject at schools in South Africa: A case of INSET teachers in Mpumalanga Province. *Procedia-Social and Behavioral Sciences, 116,* 3688-3692.

Makhubele, D. M., & Simelane-Mnisi, S. (2021). Learners' perception of learning technology subject in South African rural secondary schools. In *EDULEARN21 Proceedings* (pp. 7937-7944). IATED.

Mapotse, T. A., & Gumbo, M. T. (2013). Identifying Grade 8 and 9 technology teachers' areas of need for intervention in Limpopo Province. *Journal of Social Sciences, 36*(1), 19-28.

Mathabatha, L. N., Kola, M., & Mtshali, T. (2022). Simulations for Junior Engineering and Technology Students: Teachers' Ability to use Design Process to Promote Psychomotor Skills. Nigerian Journal of Technology, 41(6). https://doi.org/10.4314/njt.v41i6.2

Maxwell, J. A. (2021). Why qualitative methods are necessary for generalization. *Qualitative Psychology, 8*(1), 111.

Mbuvha, T. R. (2018). The prominence of in-service training on the performance of special school teachers in South Africa in the Limpopo Province. *International Journal of Technology and Inclusive Education (IJTIE), 7*(1), 1243-1250.

McEwan, B. (2020). Sampling and validity. *Annals of the International Communication Association*, *44*(3), 235-247.

McMillan, J. H., & Schumacher, S. (2010). Research in Education: Evidence-Based Inquiry, *MyEducationLab Series*. Pearson.

Micanovic, V., Novovic, T., & Maslovaric, B. (2017). Inclusive values in the planning of mathematical issues at an early age. *South African Journal of Education, 37*(2). http://dx.doi. org/10.15700/saje. v37n2a1267.

Mlachila, M. M., & Moeletsi, T. (2019). Struggling to make the Grade: A review of the causes and consequences of the weak outcomes of South Africa's education system. *IMF Working Papers No. 2019/047.*

Moila, O., Mji, A., & Mnisi, S. S. (2020). Challenges faced by lecturers in the use of fourth industrial revolution tools to equip pre-service teachers in a South African university. *World Transactions on Engineering and Technology Education (WIETE), 18*(3), 350-354.

Mokoena, J. D., Matlakala, M. C., & Tladi, F. M. (2014). Learning and assessment of nursing unit management practice using a portfolio. *Literacy Information and Computer Education Journal*, *5*(3), 1597-1601.

Molina Roldán, S., Marauri, J., Aubert, A., & Flecha, R. (2021). How inclusive interactive learning environments benefit students without special needs. *Frontiers in Psychology, 12, 1510.*

Montiel, I., Delgado-Ceballos, J., Ortiz-de-Mandojana, N., & Antolin-Lopez, R. (2020). New ways of teaching: Using technology and mobile apps to educate on societal grand challenges. *Journal of Business Ethics*, *161*, 243-251.

Moon, K., Brewer, T. D., Januchowski-Hartley, S. R., Adams, V. M., & Blackman, D. A. (2016). A guideline to improve qualitative social science publishing in ecology and conservation journals. Ecology and Society, 21(3).

Morris, J. E., & Paris, L. F. (2022). Rethinking arts-based research methods in education: Enhanced participant engagement processes to increase research credibility and knowledge translation. *International Journal of Research & Method in Education*, *45*(1), 99-112.

Mtshali, T. I., Ramaligela, S. M., & Makgato, M. (2020). Usage of digital resources in Civil Technology: A case of teaching Tools and Equipment. *African Journal of Science, Technology, Innovation and Development, 12*(1), 47-55.

Mustafa, N. (2020). Impact of the 2019-20 Coronavirus pandemic on education. *International Journal of Health Preferences Research*. https://doi.org/10.13140/RG.2.2.27946.98245

Nambiar, D. (2020). The impact of online learning during COVID-19: students' and teachers' perspective. *The International Journal of Indian Psychology*, *8*(2), 783-793.

Naude, M., & Meier, C. (2019). Elements of the physical learning environment that impact on the teaching and learning in South African Grade 1 classrooms. *South African Journal of Education, 39*(1). https://www.ajol.info/index.php/saje/article/ view/184912

Nortvig, A. M., Petersen, A. K., Helsinghof, H., & Brænder, B. (2020). Digital expansions of physical learning spaces in practice-based subjects-blended learning in Art and Craft & Design in teacher education. *Computers & Education*, *159*, 104020.

Nurbekova, Z., Grinshkun, V., Aimicheva, G., Nurbekov, B., & Tuenbaeva, K. (2020). Project-based learning approach for teaching mobile application development using

visualization technology. *International Journal of Emerging Technologies in Learning (iJET), 15*(8), 130-143.

Olimov, S. S. (2021). The innovation process is a priority in the development of pedagogical sciences. *European Journal of Research Development and Sustainability*, *2*(3), 86-88.

Önal, N. T. (2021). Investigation of technology integration knowledge of Science teachers: A case study: Investigation of technology integration knowledge. *International Journal of Curriculum and Instruction*, *13*(1), 773-793.

Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L., & Zoran, A. G. (2009). A qualitative framework for collecting and analyzing data in focus group research. *International Journal of Qualitative Methods, 8*(3), 1-21.

Osamwonyi, E. F. (2016). In-service education of teachers: Overview, problems and the way forward. *Journal of Education and Practice, 7*(26), 83-87.

Pandey, P., & Pandey, M. M. (2021). *Research methodology tools and techniques*. Bridge Center.

Patterson, E. W., Ball, K., Corkish, J., & Whittick, I. M. (2022). Do you see what I see? Enhancement of rigour in qualitative approaches to inquiry: A systematic review of evidence. *Qualitative Research Journal*, *23*(2), 164-180.

Pazin, A. H., Maat, S. M., & Mahmud, M. S. (2022). Factors influencing teachers' creative teaching: A systematic review. *Cypriot Journal of Educational Sciences, 17*(1), 240-254.

Peterson, J. S. (2019). Presenting a qualitative study: A reviewer’s perspective. *Gifted Child Quarterly*, *63*(3), 147-158.

Pickard, A., & Maude, P. (2021). *Teaching physical education creatively*. Routledge.

Ponidi, P., Waziana, W., Kristina, M., & Gumanti, M. (2020). Model of utilizing discovery learning to improve mathematical learning achievements. Attractive: *Innovative Education Journal, 2*(1), 41-48.

Prater, M. A., Redman, A. S., Anderson, D., & Gibb, G. S. (2014). Teaching adolescent students with learning disabilities to self-advocate for accommodations. *Intervention in School and Clinic, 49*(5), 298-305.

Presmeg, N. (2020). Visualization and learning in mathematics education. *Encyclopedia of Mathematics Education,* 900-904.

Preston, B. (2020). Artifacts. In *The Routledge Handbook of the Philosophy of Engineering* (pp. 209-221). Routledge.

Prozesky, D. R. (2000). Teaching and learning. *Community Eye Health, 13*(36), 60.

Rahi, S. (2017). Research design and methods: A systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics & Management Sciences, 6*(2), 1-5.

Reinsfield, E., & Lee, K. (2021). Exploring the technology teacher shortage in New Zealand: the implications for quality teaching and learning. *International Journal of Technology and Design Education*, 1-10.

Rinkevich, J. L. (2011). Creative teaching: Why it matters and where to begin. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 84*(5), 219-223.

Risan, M. (2020). Creating theory-practice linkages in teacher education: Tracing the use of practice-based artefacts. *International Journal of Educational Research, 104,* 101670.

Roberts, M., Allen, S., & Coley, D. (2020). Life cycle assessment in the building design process–A systematic literature review. *Building and Environment*, *185*, 107274.

Roller, M. R. (2019, September). A quality approach to qualitative content analysis: Similarities and differences compared to other qualitative methods. In Forum Qualitative Sozialforschung /Forum: Qualitative Social Research (Vol. 20, No. 3).

Rose, J., & Johnson, C. W. (2020). Contextualizing reliability and validity in qualitative research: Toward more rigorous and trustworthy qualitative social science in leisure research. *Journal of Leisure Research, 51*(4), 432-451.

Rosenberg, M. S., Sindelar, P. T., & Hardman, M. L. (2004). Preparing highly qualified teachers for students with emotional or behavioral disorders: The impact of NCLB and IDEA. *Behavioral Disorders, 29*(3), 266-278.

Rosnidar, R., Yusrizal, Y., Mustafa, M., & Susanna, S. (2021). Application of discovery learning model in increasing student interest and learning outcomes. *Jurnal Penelitian* Pendidikan IPA, 7(4), 542-548.

Routray, S. K., Sharma, L., Sahoo, A., Javali, A., Sharmila, K. P., & Akanksha, E. (2021, November). IoT and immersive technology based smart classrooms. In *2021 Fifth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC)* (pp. 136-141). IEEE.

Rozinah, S., & Meiriki, A. (2020). Pemanfaatan digital marketing pada usaha mikto kecil dan menengah (umkm) di kota tangerang selatan. *Jurnal Doktor Manajemen (JDM), 3*(2), 134.

Ruslin, R., Mashuri, S., Rasak, M. S. A., Alhabsyi, F., & Syam, H. (2022). Semi-structured Interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *IOSR Journal of Research & Method in Education (IOSR-JRME), 12*(1), 22-29.

Sage, K., Jackson, S., Mauer, L., & Stockdale, K. (2022). Equal in effectiveness but not yet perception: smartphones and laptops for completing brief academic tasks. *Educational Media International, 59(2), 112-130.*

Sebele-Mpofu, F. Y. (2020). Saturation controversy in qualitative research: Complexities and underlying assumptions. A literature review. *Cogent Social Sciences, 6*(1), 1838706.

Setiawan, A., Munir, A., & Suhartono, S. (2019). Students' engagement in EFL class through creative teaching. *Journal of Education and Development, 7*(3), 26-26.

Setiawan, R., Nath, K., Pio, L., Cavaliere, L. P. L., Villalba, K., Arias-Chavez, D., … & Rajest, S. S. (2020). The impact of teaching innovative strategy on academic performance in high schools. *Productivity Management, 25*(5), 1296-1312.

Sharma, G. (2017). Pros and cons of different sampling techniques. *International Journal of Applied Research, 3*(7), 749-752.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-23.

Sileyew, K. J. (2019). Research design and methodology. *Cyberspace*, 1-12.

Sinković, G., Currie, D., & Bevanda, V. (2011). From IT to BSC: The importance of culture in implementing a performance measurement system in Croatia. *Indian Journal of* Economics & Business (IJEB), 10, 39-55.

Siyam, N. (2019). Factors impacting special education teachers' acceptance and actual use of technology. *Education and Information Technologies*, 24(3), 2035-2057.

Stahl, N. A., & King, J. R. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research*. Journal of Developmental Education, 44(1), 26-28.*

Stahnke, R., & Blömeke, S. (2021). Novice and expert teachers' situation-specific skills regarding classroom management: What do they perceive, interpret and suggest? *Teaching and Teacher Education, 98*, 103243.

Subero, D., Llopart, M., Siqués, C., & Esteban-Guitart, M. (2018). The mediation of teaching and learning processes through identity artefacts. A Vygotskian perspective. *Oxford Review of Education, 44(2), 156-170.*

Suskie, L. (2018). *Assessing student learning: A common sense guide*. John Wiley & Sons.

Suyudi, M., Rahmatullah, A. S., Rachmawati, Y., & Hariyati, N. (2022). The effect of instructional leadership and creative teaching on student actualization: Student satisfaction as a mediator variable. *International Journal of Instruction, 15*(1), 113-134.

Szurmak, J., & Thuna, M. (2013). *Tell me a story: The use of narrative as tool for instruction. ACRL,16th National Conference, "Imagine, Innovate, Inspire",* Indianapolis, Indiana, April 10-13, 2013.

Terre Blanche, M. J., Durrheim, K., & Painter, D. (2014). First steps in qualitative data analysis. In Research in *practice: Applied methods for the social sciences* (pp. 320-344). Cape Town: Juta.

Thabethe, B. M. (2018). *Learning of mechanical systems in Grade 9 Technology classroom by deaf learners in KwaZulu-Natal: An exploration of a learning of Technology in a non-hearing environment.* (Doctoral dissertation, University of KwaZulu-Natal).

Vincent-Lancrin, S., Cobo Romaní, C., & Reimers, F. (2022). *How learning continued during the COVID-19 Pandemic: Global lessons from initiatives to support learners and teachers*. Paris: OCDE; Washington: The World Bank.

Walton, E., & Lloyd, G. (2012). From clinic to classroom: A model of teacher education for inclusion. *Perspectives in Education, 30*(2), 62–70.

Whitehead, D., & Whitehead, L. (2016). Sampling data and data collection in qualitative research. In *Nursing and midwifery research: Methods and appraisal for evidence-based practice* (5th ed., pp. 111-126). Churchill Livingstone: Elsevier.

Wininger, S. R., Redifer, J. L., Norman, A. D., & Ryle, M. K. (2019). Prevalence of learning styles in educational psychology and introduction to education textbooks: A content analysis. *Psychology Learning & Teaching*, *18*(3), 221-243.

Wiseman, D., Lunney Borden, L., Beatty, R., Jao, L., & Carter, E. (2020). Whole-some artifacts: (STEM) teaching and learning emerging from and contributing to community. *Canadian Journal of Science, Mathematics and Technology Education, 20*, 264-280.

Yazcayir, G., & Gurgur, H. (2021). Students with special needs in digital classrooms during the COVID-19 pandemic in Turkey. *Pedagogical Research, 6*(1).

Yin, R. K. (2014). *Case study research: Design and methods (applied social research methods)* (p. 312). Thousand Oaks, CA: Sage.

Zhi., H. L. (2014). A comparison of convenience sampling and purposive sampling. *PubMed, 61*(3), 105-111.

7. ANNEXURES

ANNEXURE A: NON-PARTICIPANT OBSERVATION TOOL

SECTION A

Teacher: _____ Lesson: _____ Date: _____		
Guiding Questions	**Observed responses**	**Comments/notes**
1. Which teaching strategy does the teacher employ?		
2. Participants teaching relevant concept within Mechanical Systems and Control in Grade 9?		
3. Selected teaching strategy engage all learners?		
4. Participants able to prompt learners' prior knowledge?		
5. What is the source of teacher's content knowledge?		

ANNEXURE B: SEMI-STRUCTURED INTERVIEW TOOL

SECTION B

Teacher: _____ **Lesson: _____** **Date: _____**	
Questions	**Responses**
1. Do you plan your lessons before going to teach?	
2. Are you able to achieve your objectives?	
3. Which challenges do you encounter mostly in your class when teaching learners with special needs?	
4. Are you able to prompt learners' prior knowledge before introducing a topic?	
5. Are you able to complete content planned for the day?	

SECTION C

Teacher: _____ **Lesson: _____** **Date: _____**	
Questions	**Responses**
1. Do you ever administer Mini-PAT with your learners?	
2. Are you able to administer the Mini-pat successfully?	
3. Are your learners completing the Mini-Pat individually or in groups?	
4. How do you ensure all learners acquire necessary skills and values when completing Mini-Pat?	

8. APPENDIX

APPENDIX A: LETTER TO THE PRINCIPAL TO CONDUCT RESEARCH

P O BOX 1159
CHUENESPOORT
0745
___ APRIL 2023

THE PRINCIPAL

Private Bag X4026

Seshego

0742

Dear Madam

REQUEST TO CONDUCT RESEARCH IN YOUR SCHOOL

I, Kekana KE, a Master's student at the University of Limpopo (UL), am writing to request permission to undertake the research project named "EXPLORING CREATIVE STRATEGIES FOR TEACHING MECHANICAL SYSTEMS AND CONTROL TO GRADE N I N E (9) LEARNERS WITH SPECIAL L E A R N I N G NEEDS". I'd like to do the research study with 9th Grade teachers and learners. This research will involve watching Grade 9 instructors as they teach mechanical systems to learners with emotional and behavioural disorders. It will include interviews with instructors about the pedagogical issues they face while educating learners with special needs.

This research was carried out under the direction of Mr TI Mtshali of the School of Education's Department of Math, Science, and Technology. I am writing to request your permission to visit your school and conduct my research, as well as the provision of volunteers for this study.

If you require any further information, please do not hesitate to contactme on 0658977559 or email: lizzykekana.262@gmail.com.

Your consideration will be highly appreciated.

Yours sincerely

Kekana, K.E

APPENDIX B: PARTICIPANTS' CONSENT FORM

To: Participant (Technology teacher)

I am Katane Elizabeth Kekana from the University of Limpopo's School of Education, which is part of the department of Mathematics, Science and Technology. You are encouraged to consider taking part in a project that entails conducting research in your school's Grade 9 classrooms on the teaching of Technology content: Mechanical Systems and Control.

TITLE: EXPLORING CREATIVE STRATEGIES FOR MECHANICAL SYSTEMS AND CONTROLTO GRADE NINE (9) LEARNERS WITH SPECIAL LEARNING NEEDS"

Risks and Benefits: There is no risk involved in this study. It will only take a small amount of your time because the study will focus on how you teach Technology content: Mechanical Systems and Control to Grade 9 learners. The findings could help to improve the teaching methodologies used to teach mechanical systems to EBD learner.

Confidentiality and Anonymity: Throughout the research, ethics will be a major consideration. Participants will be kept anonymous, and pseudonyms will be utilized.

Voluntary Participation: You are welcome to participate as a volunteer and to withdraw at any moment.

Consent Statement: I accept to participate in this study and consent to the above after reading the above. In addition, I agree not to reveal any information that could be related to a specific person. Finally, I recognise that a copy of this form has been sent to me.

I....., have been notified about Kekana Katane Elizabeth's work titled "Teaching of Mechanical Systems and Control in Grade 9 Technology classroom to learners with Special learning needs."

…….. ……

…… ……..

(Signature of participant and date) (Signature of researcher and date)

I appreciate your participation.

APPENDIX C: PARENTS' CONSENT FORM

Title of the study: Exploring creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special needs in the Capricorn District.

This serves as permission for Kekana, Katane Elizabeth (researcher) to conduct research on your child while he/she will be participating in the study.

Kekana, Katane Elizabeth (researcher) is registered as a University of Limpopo student at Masters level.

Parent/guardian

☐ I agree that my child will participate in a programme of research conducted at the school.

☐ I understand that my daughter's/son's name will be false name to maintain confidentiality.

☐ I understand that, upon request, I may have a full description of the results of the study after its completion.

☐ I understand that the data from this study may be published.

I understand that my child is free to withdraw from this study at any time without negative consequences.

I HAVE READ AND UNDERSTOOD THIS CONSENT FORM AND I THEREFORE, GRANT PERMISSION FOR MY CHILD TO PARTICIPATE IN THE STUDY.

Signatures

Learner's signature:_____

Signature of parent/guardian: _____

Date:_____

Cell/Telephone number:_____

APPENDIX D: LEARNERS' ASSENT FORM

Title of the study: Exploring creative teaching strategies for teaching Mechanical Systems and Control to Grade 9 learners with special needs in the Capricorn District.

This serves as a request for permission to conduct research on your class where you will be participating on the study.

Name of researcher: Kekana Katane Elizabeth

Participants

☐ I agree to participate in a programme of research conducted by Kekana Katane Elizabeth at the special School.

☐ I understand that my name will be hidden to maintain confidentiality.

☐ I understand that, upon request, I may have a full description of the results study after its completion.

☐ I understand that the data from this study may be published.

☐ I understand that I am free to withdraw from this study at any time without negative consequences.

I HAVE READ AND UNDERSTOOD THIS CONSENT FORM AND I AGREE TO PARTICIPATE IN THE STUDY.

Signature of learner: …….

Date: ……

Cell/Telephone number: .....

APPENDIX E: LANGUAGE EDITOR'S CERTIFICATE

Cell: 076 389 3246
gill.hannant@outlook.com

Mrs G Hannant
28 Hillcrest Avenue
CRAIGHALL PARK
2196

27 July 2023

TO WHOM IT MAY CONCERN

I certify that I have edited the Master's dissertation

EXPLORING CREATIVE TEACHING STRATEGIES FOR TEACHING MECHANICAL SYSTEMS AND CONTROL TO GRADE NINE (9) LEARNERS WITH SPECIAL NEEDS IN CAPRICORN DISTRICT

by

Katane Elizabeth Kekana

However, the correction of all errors/missing information remains the responsibility of the author.

G.C. HANNANT
BA HED

APPENDIX F: ETHICAL CLEARANCE

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3935 Fax: (015) 268 2306 Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: 22 August 2022

PROJECT NUMBER: TREC/375/2022: PG

PROJECT:

Title:	Exploring Creative Strategies for Teaching Mechanical Systems and Control to Grade Nine (9) Learners with Special Needs in the Capricorn District Cluster.
Researcher:	KE Kekana
Supervisor:	Mr. TI Mtshali
Co-Supervisor/s:	Prof. MS Ramaligela
School:	Education
Degree:	Master of Education inTechnology

PROF D MAPOSA
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from theresearch procedure as approved, the researcher(s) must resubmit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

APPENDIX G: PERMISION TO CONDUCT STUDY

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

CONFIDENTIAL

Ref: 2/2/2 Enq: Makola MC Tel No: 015 290 9448 E-mail:MakolaMC@edu.limpopo.gov.za

Kekana KE
Private Bag x1106
Sovenga
0727

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"EXPLORING CREATIVE STRATEGIES FOR TEACHING MECHANICAL SYSTEMS AND CONTROL TO GRADE NINE (9) LEARNERS WITH SPECIAL NEEDS IN THE CAPRICORN DISTRICT CLUSTER "**
3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the School concerned.

3.3 The conduct of research should not in anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560