

## Inventive Ways of Teaching Mechanical Systems and Control to Grade 9 Learners with Special Learning Needs

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### Abstract

Mechanical systems and control are part of the Technology subject strand, which involves gaining knowledge and skills in using various machinery and mechanisms such as gears, belts, chains, elevators, and escalators. Technology teachers need to be familiar with innovative teaching methods for instructing learners with special needs. This study aimed to explore creative teaching strategies for teaching Mechanical Systems and Control to grade 9 learners with special needs in the Capricorn district of Limpopo. A qualitative exploratory case study design and homogenous purposive sampling were employed to select two Technology teachers from two special schools in the Capricorn district. The findings of this study revealed that technology teachers encountered significant challenges in identifying and implementing appropriate creative teaching strategies to deliver the content of Mechanical Systems and Control effectively to learners with special learning needs. The study also indicated that although Technology teachers utilized PowerPoint presentations, narrative discourses, textbooks, and artifacts during instruction, these strategies were not always effective for learners with special learning needs. Consequently, the study recommends that teachers receive comprehensive training on teaching learners with special learning needs, focusing on different pedagogies and methods such as the guided exploration method, technology integration, visualization, and the use of technological artifacts to enhance instruction in Mechanical Systems and Control. These learner-centered methods enable teachers to cater to learners' individual learning needs.

**Keywords:** Special needs; Technology; Mechanical Systems and Control

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## INTRODUCTION

Teaching any learner can be challenging, but the challenge is even greater when a teacher is faced with learners who have different learning needs. In our schools, we have learners with low concentration spans, hyperactivity, and autism. These learners deserve quality education like any other public or private school learner. However, it is important to recognize that learners with special needs require additional attention, and teachers must carefully select pedagogical strategies and resources to ensure that they understand the concepts being taught.

While there is literature available on teaching learners with poor vision or those in wheelchairs, there is relatively little known about how to teach a learner with a low concentration span effectively. While there may be teachers who have made progress

in teaching such learners, there is a lack of studies in the South African context that provide guidance on teaching learners with autism, particularly in the context of engineering subjects. Technology is one such subject that heavily focuses on engineering concepts.

This study focuses on technology teachers who teach basic mechanical engineering concepts to learners with special needs, specifically in grade 9. There is a scarcity of literature on teaching technology subjects. Mtshali and Singh-Pillay (2023) argue that there is a lack of understanding of various aspects of technology teacher pedagogical knowledge. Therefore, this study aims to contribute to the literature by exploring innovative ways to teach learners with low concentration spans and autism, among other special needs. The competency of teachers in teaching mechanical systems and control concepts is crucial for these learners, as it directly affects their potential contribution to the economy. The technology curriculum requires teachers to transmit theoretical information to learners and develop their skills in applying that knowledge. This approach encourages learners to actively engage in their own learning and take responsibility for it.

Creative teaching strategies are becoming essential skills for teachers to enhance the learning experience of learners with special needs. The use of these strategies helps learners master basic scientific skills and acquire conceptual knowledge in challenging subjects like Technology (Greenier et al., 2023). According to Fadzil et al. (2022), teaching strategies such as demonstrations, guided exploration methods, technology integration, technological artifacts, and visualization are effective for learners with special needs. These strategies improve learner participation in problem-solving and emphasize hands-on learning experiences, which are crucial for understanding Mechanical Systems and Control concepts (Mathabata et al., 2023). Therefore, it is important to explore creative teaching strategies that Technology teachers can use to create a learner-centered environment for learners with special needs. This study aims to investigate such strategies for teaching Mechanical Systems and Control to learners with special needs.

## Literature review

### *Teaching learners with special learning needs*

To reiterate, there is a lack of studies addressing learning difficulties associated with learners with special needs in vocationally based Technology, particularly when it comes to creative teaching strategies. Hlophe (2020) support the view that learners with special needs have not received sufficient attention in teaching events, despite the need for vocational skills from all types of learners in schools. Teachers who teach learners with special needs, such as autism, intellectual difficulties, and behavioral disorders, are compelled to find creative teaching strategies to cater to their learning needs (Hlophe, 2020). Therefore, this study focuses on under-researched yet empirically observed creative teaching strategies for teaching Mechanical Systems and Control to learners with special needs, contributing to the discourse on Technology learning.

The right to education is considered a universal human right, and the No Child Left Behind Act of 2001 was enacted to address the world's significant disparities. However, learners with special needs have not fully benefited from this act. Technology teachers have not been proactive in finding innovative ways to teach their learners. In fact, Sibiya et al. (2023) found that Technology teachers' creative strategies

for teaching "normal" learners are relatively stagnant. There is a pressing need to propose effective strategies for Technology teachers to accommodate all learners in technology content activities, ensuring equal access to education.

The No Child Left Behind Act of 2001 also emphasizes the need for teachers to be highly competent and strategic in their instructional activities (Rosenberg et al., 2004). This implies that Technology teachers must constantly find innovative ways to teach, benefiting learners with special needs as well. On the other hand, Makgato (2014) argues that Technology teachers still struggle to find and use appropriate methods for delivering Technology content knowledge. For example, the Mechanical Systems and Control topic in grade 9 requires learners to learn about levers, inclined planes, screws, gears, and pulleys. Learning this content involves conducting experiments, hands-on investigations, and building working models. However, there is limited literature on how teachers in special needs schools in the Limpopo province teach the Mechanical Systems and Control topic to learners with special needs. Therefore, it is necessary to bridge this knowledge gap by exploring creative teaching strategies for learners with special needs.

The pandemic has affected both developed and underdeveloped countries, with consequences ranging from political, academic, economic, health, and cultural impacts, among others. In the academic realm, the virus has had a significant impact on schools, particularly in South Africa, a developing country. This incident has affected teaching pedagogy and altered the processes that take place in schools or classrooms. The untimely development and influence of the pandemic on content and lesson delivery in schools, Technical and Vocational Education and Training (TVET) institutions, and universities raise questions about the use of traditional teaching methodologies for learners with special needs. Learners with special needs often have various learning difficulties and require close supervision. Therefore, it is essential to enhance current teaching practices. Moreover, this need arises at a time when many Technology teachers are still facing challenges in creating learning activities that develop and maintain hands-on skills.

### ***Teaching Technology and vocational subjects in schools***

Mechanical Systems and Control in Technology aim to provide learners with knowledge and skills in building facilities using various machines, including gears, belts, chains, elevators, and escalators (Department of Basic Education, 2014). However, most Technology teachers lack the ability to operate these machines. They rely on conventional teaching methods, such as textbooks, which encourage learners to imagine concepts rather than providing real-life examples. This approach also limits learners' understanding of the curriculum. Moreover, teachers rarely offer practical examples or demonstrations, particularly for learners with special needs who may have difficulty retaining information and learn best through visuals and audio (Mabasa et al., 2023). Consequently, Technology teachers who educate students with special needs are relieved of the responsibility to provide close supervision during practical activities or machine operation to meet curriculum requirements.

According to Mokoena et al. (2014), teachers need to be creative and innovative when teaching technological concepts, including Mechanical Systems and Control. However, the strategies for teaching this content are not clearly outlined. Additionally, there is a lack of research on how Technology teachers can fulfill these goals for learners with special needs, particularly in the context of the pandemic. This study aims to address this knowledge gap and provide inventive ways for Technology

teachers to teach learners with special needs. The proposed creative methods aim to engage and enhance understanding among learners with special needs by demonstrating how mechanical concepts can be applied to real-life situations. Furthermore, these methods allow teachers to design practical assignments and procedures that are easily comprehensible for students (Ashipala et al., 2023).

This study had the following concern to investigate The main research question on “How do Technology teachers effectively teach Mechanical systems and control to learners with special learning needs?”. This main research question is followed by subsidiary questions:

1. How do teachers utilize digital resources for learners with special learning needs?
2. How do teachers utilize artifacts to teach learners with special learning needs?
3. How do teachers utilize narratives to teach learners with special needs?

By exploring these questions, this study makes a significant contribution to the field of Technology education, particularly in understanding effective teaching strategies for students with special needs. This area of research has received limited attention thus far. To address these questions, this study is grounded in Shulman's (1987) concept of Content and Pedagogical Knowledge, which will be discussed in the following section.

### *Pedagogical Content Knowledge as a Framework*

Shulman's (1987) conceptual framework was introduced to educational research to assist teachers in effectively transforming content knowledge into pedagogical forms. Shulman (1987) categorizes seven knowledge bases for teachers: content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational history and philosophy.

Content Knowledge (CK) encompasses understanding of concepts, explanations, ideas, proofs, practical examples, and processes and models for developing this knowledge (Shulman, 1987). This study considers content knowledge as the foundational base teachers must possess to have a deep and flexible understanding of the subject matter. This enables them to assist learners in developing cognitive maps and teach them according to current standards.

Shulman's Content Knowledge aligns with the research objective of exploring how instructors use artifacts to teach learners with special needs. CK aids in comprehending instructors' mastery of Mechanical Systems and Control concepts, such as gears, levers, pulleys, and more. It enables understanding of processes like pneumatic and hydraulic systems, among others, and facilitates practical work that requires comprehension of tools and materials needed for project completion.

Pedagogical Content Knowledge (PCK) is one of the crucial knowledge domains for instructors. PCK involves understanding what makes learning specific topics easier or more challenging. Shulman's PCK aligns with the research goal of examining how teachers use narratives to teach learners with special needs. This helps teachers determine how to simplify or make the Mechanical Systems and Control curriculum more challenging for learners with special needs. Knowledge is broken down to suit the cognitive level of the learner, and familiar language and concepts are employed.

According to Shulman (1987), knowledge of learners and their characteristics pertains to the teacher's understanding of learners' potential ideas about the subject. This is done to develop explanations that either challenge or confirm preconceived



notions. Knowledge of educational context (KEC) refers to understanding the various settings where learning occurs (Shulman, 1987). It encompasses awareness of instructional situations, class and group dynamics, and broader school and community culture aspects. KEC aligns with the study's objective of exploring how teachers use digital resources for students with special needs. It helps instructors comprehend how to utilize assistive technology to enhance teaching and learning.

Effective teaching is not a matter of chance but requires teachers to deeply understand the content and how it can be enhanced through technology implementation. Teachers must possess both pedagogical and content knowledge and an understanding of technology to ensure learning is in line with the demands of the modern era (Kim, 2018).

## **METHOD**

### **Research Approach**

This study utilized a qualitative approach, specifically focusing on the case study method. A qualitative approach is a research method that emphasizes gathering data through open-ended and conversational communication (Hollweck, 2015). In this study, the chosen method involved conducting interviews with participants to explore how teachers creatively teach Mechanical Systems and Control to learners with special needs. The decision to use a qualitative research approach was driven by the aim of understanding and exploring the complex and contextual nature of the teaching practices employed by teachers in the research site (Peterson, 2019). This approach aimed to gather in-depth data on how participants utilize digital resources, artifacts, and narratives when teaching learners with special needs.

Furthermore, the adoption of a qualitative approach in this study allowed for the collection of data on participants' experiences with the teaching strategies employed for teaching Mechanical Systems and Control to learners with special needs. This comprehensive method provided a thorough understanding of the ongoing process of teaching, as opposed to a superficial overview of the employed strategies (Sebele-Mpofu, 2020).

Qualitative research was chosen because of its effectiveness in classifying, organizing, and interpreting relevant data acquired through qualitative means (Onwuegbuzie et al., 2009). The objective of this study was to shed light on social issues while maintaining the integrity of the surrounding environment. Ultimately, the qualitative research approach enabled the researcher to achieve the study's aim of exploring creative strategies for teaching Mechanical Systems and Control to grade 9 learners with special needs in the Capricorn District of Limpopo. Additionally, this approach provided the most effective tools for investigating complex phenomena and intricate systems.

### **Research Design**

An exploratory case study design was utilized to investigate the creative strategies employed by teachers in instructing Mechanical systems and control to grade 9 learners with special needs. A case study is defined as a singular entity, a unit with delineated boundaries that can be an individual, a program, a group, or a specific policy, which focuses on a particular scenario, event, or phenomena (Yin, 2014). The exploratory case study method was selected due to the limited existing research on

effective approaches for teaching Mechanical systems and control to grade 9 learners with special needs.

Given that the two selected special schools accommodated special needs learners with similar characteristics, a single case study research approach was fitting for this study. The special schools shared the commonality of serving learners with autism, intellectual disabilities, and behavioral disorders. Moreover, since the research aims to gather data on how such learners with the aforementioned traits can be creatively instructed in Mechanical systems and control, this approach is suitable.

### **Population**

Population selection entails choosing a sample of participants that accurately represents the entire population and possesses shared characteristics (Rahi, 2017). In the Limpopo Capricorn region, there were two schools dedicated to educating learners with special needs. These schools were utilized as the population for this study. Therefore, the population for this research encompassed all special schools within the South and North Capricorn Districts of Limpopo Province, South Africa, that offered the Technology subject to grade 9 students. The researcher specifically focused on grade 9 Technology teachers who were instructing learners with special needs in these special schools.

### **Sampling**

This study utilized the homogenous purposive sampling method and convenience sampling. According to Suen (2014), homogenous sampling is when the researcher specifically selects participants who share similar traits, such as culture, job title, and life experiences. In this study, we selected grade 9 Technology teachers who taught learners with special needs, specifically those with autism, intellectual difficulties, and behavioral disorder, in order to focus on these specific similarities and their relevance to the research topic.

Etikan et al. (2016) define convenience sampling as the practice of gathering data from participants who are easily accessible and can be contacted with ease. Therefore, we selected participants who were located nearby within the same district to ensure continuous data collection. The study required the researcher to observe various lessons for approximately three weeks to gather sufficient data on how grade 9 Technology teachers teach mechanical systems and control to learners with special needs. The teachers indicated that they needed to allocate three weeks for teaching the concepts of mechanical systems and control due to the specific learning needs of their students. As mentioned earlier, the focus of the study was on teachers in a special school within the North and South Capricorn District.

### **Data Collection Techniques**

Since this study is qualitative in nature, the researcher employed two data collection techniques: non-participant observation and semi-structured interviews. These methods were chosen to ensure a more unbiased evaluation of the events and to gather comprehensive data. The non-participant observation involved video recordings, photographs, and field notes to document the teaching strategies and methods employed by the participants in delivering the content on Mechanical Systems and Control. The field notes were also derived from the responses gathered during the interviews.

The semi-structured interviews were conducted to gauge the effectiveness of the teaching strategies used by teachers in teaching Mechanical Systems and Control to

learners with special needs. The interviews aimed to explore the following aspects: (1) the use of digital resources by teachers for learners with special needs, including their effectiveness in teaching students with autism, intellectual disability, and behavioral disorders; (2) the utilization of artifacts by teachers in teaching learners with special needs, including their knowledge of handling tools and materials and selecting appropriate resources for tasks; and (3) the use of narratives by teachers in teaching learners with special needs, including their ability to deliver content knowledge through narratives that are familiar to the students. Additionally, the interviews aimed to assess how teachers ensure that learners have acquired the relevant concepts within the content while using narratives.

### **Data Analysis**

The collected data were analyzed using thematic analysis, specifically Shulman's (1987) theory of content and pedagogical knowledge. Thematic analysis is a process for analyzing qualitative data that involves identifying, analyzing, and reporting repeated patterns across a data set (Braun & Clarke, 2006). The videos and pictures were manually transcribed into narratives and analyzed. We familiarized ourselves with the transcripts and recordings, took notes, and generated codes to create themes. According to Braun and Clarke (2013), this process involves grouping codes that share similarities to reflect a comprehensible and meaningful pattern in the data. We then examined all the themes in light of the coded data to identify any logical patterns. This allowed us to recognize distinct themes and demonstrate how they were combined to tell a narrative using the data.

The lessons of the two teachers were analyzed descriptively. Both participants were recorded teaching specific topics related to Mechanical systems and control. The video clips were examined to identify the topic of each lesson, analyze the teaching approach used, and determine effectiveness by focusing on learner responses. Participants were also interviewed for accuracy considerations. The data from the semi-structured interviews were coded, analyzed, and discussed thematically. The collected data were examined, patterns were identified, and themes were pinpointed. Thematic analysis was used to discuss the codes and meaningful patterns (McMillan & Schumacher, 2014).

### **Trustworthiness of the Qualitative Instruments**

To ensure the trustworthiness of the study's findings, four main criteria - credibility, transferability, dependability, and confirmability - were carefully addressed. Credibility was ensured by videotaping the lessons, capturing the true occurrences without any tampering. Field notes were taken to document the observations, and the participants' responses during interviews were recorded. Additionally, member checking was employed to validate the collected data by comparing it with the participants' own accounts. After the data analysis, participants were visited at their respective schools to verify the consistency between the data and their responses.

The study focused on two Technology teachers who taught grade 9 learners with special needs in the Capricorn District. The findings, which can be of value to other teachers working with similar learners, were shared among the participants. Dependability was maintained by involving the participants in a sustained and focused discussion throughout the analysis, using consistent data collection methods such as video tapes and field notes to minimize subjectivity. These discussions were

conducted to ensure a shared understanding of the study between the researcher and the participants.

For each lesson that was videotaped and each interview conducted, the participants were given the opportunity to review the videos and their responses. Subsequently, the presentation of the findings was discussed to confirm accuracy and agreement with the participants.

Confirmability was achieved by allowing the participants to review the research report and provide feedback on the interview responses. They were provided with copies of the final report to read and ensure their identities were not disclosed. To protect the identity of the participants, who were from a limited number of special schools in the South and North Capricorn districts, alphabetical code names were used. The exact sub-district where the study took place was also not revealed to prevent any inadvertent exposure of the participants. It is important to note that the data collected in this study were solely used for the purposes of the study and were treated with confidentiality and ethical considerations in mind.

### **Ethical Statement**

This study, which adopts a qualitative approach with a particular focus on case study methods, places a high priority on ethical considerations in both its research design and execution, particularly with regard to the participants involved. The participants in this study consist of grade 9 Technology teachers and learners with special needs in the Capricorn District of Limpopo. They were engaged through non-participant observations and semi-structured interviews. To ensure the ethical treatment of participants, stringent ethical protocols were followed, including obtaining informed consent and ensuring the confidentiality and anonymity of all participants. Participant identities were protected through the use of code names, and specific geographical details were omitted to prevent indirect identification. The data collection methods employed were chosen with the aim of respecting the dignity and privacy of all participants, and ethical approval was obtained to ensure compliance with these measures. This approach highlights the research's dedication to upholding ethical standards in qualitative research, ensuring that the rights and well-being of participants are safeguarded throughout the study.

## **RESULTS AND DISCUSSION**

This section delves into the empirical findings and the corresponding discussions related to those findings.

### **Non-participants Observation Findings**

The non-participants observations responded to : (1) the utilization of digital resources by teachers for learners with special needs, (2) the incorporation of narratives in teaching learners with special needs, and (3) the use of artifacts for teaching learners with special needs. The design of the observation tool was based on Shulman's (1987) pedagogical content knowledge framework. The observations were carried out during teaching and learning sessions to explore innovative teaching strategies employed by Technology teachers when teaching Mechanical Systems and Control to grade 9 learners with special needs.

The observations took place starting from the second week of term two, when the concepts of Mechanical Systems and Control were being taught. The participants were observed on four occasions, with each lesson lasting for 60 minutes. The



observation schedule was structured in a manner that facilitated the noting of teaching strategies employed by the participants. The schedule included guiding questions extracted from the theoretical framework, as well as a section for comments. The tool was utilized to ensure an unbiased assessment of the observed activities.

### ***The use of Digital Resources in a Special Education Classroom***

The use of digital resources in schools is increasing as a means to deliver educational knowledge and skills in new and innovative ways (Mtshali et al., 2020). Current educational standards emphasize the importance of providing opportunities for special needs learners to reach their full potential. These learners should not experience discrimination but should be allowed to engage in education and training on equal terms with learners without impairments.

Therefore, special education teachers must strive to accommodate learners with special needs by integrating education with digital resources. There are various educational technologies that teachers should be familiar with in order to cater to all learners, regardless of their learning needs. When Teachers A and B were asked how they creatively teach Mechanical Systems and Control to learners with special needs, both emphasized 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 observations, teacher A presented a lesson using a digital projector and laptop to show learners an animation related to the concept of rotation of gears within the topic of gear systems. The PowerPoint presentation focused on the content of Mechanical Systems and Control gear systems, specifically the rotation of gears clockwise and anticlockwise. An animation was displayed while the teacher provided an explanation. Most learners were engaged and focused on what was being displayed. However, a learner with autism seemed to lose interest before the video was complete. Despite this, the teacher insisted on repeating the video for other learners to watch, neglecting the autistic learner. Although teachers attempt to use technology to engage special needs learners, some are still left behind. Nevertheless, it is the responsibility of teachers to engage all learners during teaching and learning, especially those with conditions such as autism who may easily become bored. Teachers may provide these learners with tablets programmed for learning to further engage them, in addition to using laptops and projectors.

Teacher B introduced the lesson by using an activity accessed on learners' laptops. The activity involved the use of gears in real-life situations. The lesson focused on Mechanical Control Systems. Continuing with the lesson, teacher B explained the concept of mechanical systems using the pictures displayed on learners' screens. She described gear systems as wheels with teeth, emphasizing their application in real-life situations. She utilized a program on laptops and instructed 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. The teacher used the animation to teach about different mechanical control systems, such as a car disc braking system. However, a learner with intellectual difficulties struggled to comprehend and follow the teacher's instructions, resulting in incomplete work.

### ***The use of Narrative Discourses in a Special Education Classroom***

According to Szurmak and Thuna (2013), incorporating narratives requires

teachers to have a strong understanding of the subject matter in order to develop stories that are relevant to the lesson's objectives. During a lesson observation, Teacher A used a story to explain the concept of clockwise and counterclockwise movement of gears. The story involved a neighbor driving home from work and using a remote-control access device to open and close his gate. The opening of the gate represented clockwise movement, while the closing of the gate represented counterclockwise movement of gears.

While teaching and learning were taking place, a student with intellectual difficulties began interjecting and adding comments to the teacher's narrative about the remote-control gate. This student wanted to know if the gate would open without the remote. This question sparked a debate among the students, with some saying that the gate would only open with the remote, while the student with intellectual difficulties argued that it could also be opened manually. The teacher intervened and explained that the gate could only be opened with a remote device because it has a motor kit and sensor. The students then asked what a motor kit is.

The teacher attempted to explain what a motor kit is, but the student still seemed confused. The use of narratives is effective when the teacher utilizes scenarios that students are familiar with and can easily relate to (Prins et al., 2017). This approach also requires the teacher to be creative and think critically. Finally, narratives must be relevant to the concepts and content of the subject. Continuing with the lesson, a student asked the teacher what would happen to the rotation of gears if a third gear was added. Teacher A tried to provide an answer, but it was unsatisfactory to the student, who remained unclear.

Teacher B used a story to explain the concept of a driver gear and driven gear. The story involved a 7-year-old son taking a bus to a township with his mother. Teacher B asked the students, "Normally there are a lot of people and stores in a mall. What can the mother do to ensure she doesn't lose her son?"

The students gave various responses, but one response satisfied the teacher: "The mother can hold her child's hand." The teacher followed up with a question, asking if it is the child who should hold the mother's hand or if it is the mother who should hold the child's hand. Most of the students indicated that the mother should hold the child's hand. Therefore, the teacher explained that since the mother is the one holding the child's hand, she is considered the driver gear, while the child is considered the driven gear. Participants noted that although they sometimes use narratives, they pointed out that not all students understand and are able to follow along with the narratives.

### ***The use of Artifacts in a Special Education Classroom***

Technology artifacts are physical items with intended uses. Anything a teacher utilizes to convey aspects of practice is considered an artifact. Teacher A used a hydraulic jack as an artifact to describe and explain the function of the hydraulic system. Teacher A conducted a whole class discussion on various methods mechanics can use to lift an engine for vehicle service purposes. Additionally, they provided information on ancient methods of lifting cars or engines. The teacher also engaged the learners in understanding how a hydraulic system works, particularly in lifting heavy machinery.

The use of artifacts proved to be effective, as all learners were engaged and displayed interest in the lesson. This was evident when a learner tested the use of a hydraulic jack to lift an engine and observe its functionality. Teacher A also used a

braking disc to describe the components of a car's braking system. They explained and elaborated on how the braking system brings a car to a stop. The learners were actively involved through a step-by-step demonstration of the braking system, with one learner being instructed to assemble the artifact. This teaching method was effective, as all learners were attentive and eager to see and touch the object. Furthermore, the teacher randomly selected learners to answer questions related to the presentation, and the learners enthusiastically participated by shouting out the responses.

However, despite the effectiveness of using artifacts, managing the learners proved to be a challenge for the teacher. The learners all wanted to touch and assemble the braking system artifact simultaneously. It was only when learners were grouped and assigned group leaders that progress and control were achieved. Learners were instructed to rotate in groups to touch and experience assembling the braking artifact. Additionally, when learners were informed that misbehavior would result in being removed from the classroom, most of them behaved appropriately.

In contrast, Teacher B rarely used artifacts to teach content in Mechanical Systems and Control. Although the artifact used was not relevant to the subject matter, it demonstrates that the teacher possesses knowledge of utilizing artifacts. During a lesson observation, a learner was creating an artificial fascinator hat for a woman. The learner made use of a Mannequin Head Plastic and a hat board to shape the fascinator hat.

### ***The use of Textbooks in a Special Education Classroom***

Textbooks are still regarded as the most authoritative source of information by teachers in schools. Mathabatha et al. (2023) argue that this is because many technology teachers still lack understanding of the subject matter and how to teach it. Moila et al. (2020) confirm that the recruitment process for most technology teachers focuses more on filling a teacher's workload than assessing their competency to teach technology. The Department of Education recommends several technology textbooks for senior phase subjects. As the main curriculum resource, textbooks play a crucial role in teaching and learning academic subjects (Wininger et al., 2019).

Therefore, it can be argued that textbooks significantly impact learners' ability to achieve curriculum objectives (Wininger et al., 2019). Textbooks continue to be the primary educational resource used to support the mandated curriculum (Wininger et al., 2019). Both participants in this study used at least one grade 9 technology textbook. Teacher A used the Spot-On Grade 9 Technology textbook, while Teacher B utilized the Platinum Grade 9 textbook. However, both teachers stated that they rarely used the textbooks for instruction and learning, but rather for lesson preparation. Participants mentioned that the reason for not using textbooks extensively is due to learners with special needs. They explained that many learners frequently lose or damage their textbooks. Therefore, it is best to provide access to textbooks only when necessary. Teacher A also used a guide that summarizes chapters on mechanics and various activities. They mentioned that each learner receives the guide only when there is an activity to complete.

### ***Semi-structured Interview Findings***

The interviews with each teacher took place after observing every lesson for approximately 30-40 minutes. The purpose of these interviews was to assess the effectiveness of the teaching strategies employed by the teachers when teaching Mechanical Systems and Control to grade 9 learners with special needs. Additionally,

the interviews aimed to confirm the observations made during the lessons.

### **Interviews on the use of Digital Resources**

How can you ensure that your students are actively participating in class throughout the lesson? *"To engage my students, I occasionally use a laptop and projector to show videos demonstrating how tools are used and their purpose."* - Teacher A (interview). *"I sometimes utilize a laptop or internet pictures to provide visual aids for what I am teaching."* - Teacher B (interview).

Participants indicated that they sometimes utilized digital resources for teaching and learning. However, adapting to students with special needs proved challenging as many of them had not been exposed to educational digital resources (Aas et al., 2024). Teacher B further explained that "managing the devices requires additional responsibility, particularly with students who have behavioral disorders" - Teacher B (interview).

Participants were asked if they could use digital resources independently. The participants responded that while some had basic knowledge of using digital resources, they still required assistance from colleagues to set up for the lesson. It can be concluded that the participants possess the necessary knowledge to use educational devices, as both could utilize digital resources successfully. According to a study by Falloon (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.

### **Interviews on the use of narrative discourses.**

Participants were asked if the use of narratives is effective for learners with special needs. Participants expressed that while they occasionally utilize narratives, they noted that learners do not always comprehend and are unable to follow the narratives. *"I have employed stories to elucidate certain concepts within the content. For example, explaining a car's braking failure. However, my learner with autism is the one who struggles to grasp the stories."* - Teacher A (interview). *"At times, I employ narratives to provide learners with examples relevant to the topic of the day, in order to engage them. However, not all of them are able to relate to the stories, and some even remain confused."* - Teacher B (interview).

Participants were asked which learners, in particular, are less likely to comprehend the narratives. Participants responded as follows: *"Most often, it is (mention the name of a learner) who is diagnosed with autism that is less likely to understand the narratives."* - Teacher A (interview). *"A few of my learners (pointing them out during the lesson) are the ones who sometimes struggle to comprehend, and they are likely to remain confused."* - Teacher B (interview).

Participants' responses indicated that teaching using narratives is beneficial for learners with special needs. This is supported by Baas's (2022) study, which found that teaching through narratives enables learners to construct their own understanding by evaluating the reality that surrounds them and developing their own interpretation. Additionally, according to Asma (2021), the ability of narratives to contextualize content to educational experiences supports the diversity of learners, enhances their self-esteem, and improves their social and psychological skills.

### **Interview on the use of Textbook**

There are recommended textbooks for senior phase Technology subjects by the



Department of Education. As the main curriculum materials, textbooks play a crucial role in both teaching and learning academic subjects (Wininger et al., 2019).

How frequently do you utilize textbooks during teaching and learning? Both participants used at least one of the grade 9 technology textbooks. Teacher A used the Spot-On Grade 9 Technology textbook, while Teacher B used the Platinum Grade 9 textbook. However, both teachers mentioned that they rarely used them for instruction and learning, but rather for lesson preparation.

Participants further explained that learners are not given guides or books to take home because they often lose them. As a result, the school incurs costs in preparing guides and ordering textbooks for learners multiple times. The books are stored in the cupboards. - Teacher A (interview). Teacher B's class frequently uses a textbook and worksheets downloaded online. *"I don't assign homework to learners as they usually don't complete it. Many parents are not actively engaged in monitoring their children's progress with schoolwork."* - Teacher B (interview)

### **Interview on the use of Artifacts**

Is the use of artifacts effective for teaching learners with special needs? Participants responded, *"Using artifacts enables my learners to better understand mechanical systems and control concepts,"* said Teacher A during the interview. *"Using artifacts enables my learners to remain engaged throughout the lesson, although close monitoring is required as they tend to fight over the artifacts,"* mentioned Teacher B during the interview.

### **Discussions of Findings**

This section concludes by discussing the findings based on the themes that emerged from the theoretical framework. The findings are presented under four themes: content knowledge, pedagogical content knowledge, educational context, and knowledge of learners and their characteristics.

#### ***Content Knowledge***

The findings revealed that participants had inadequate knowledge of the subject matter, as they were unable to answer the questions raised by learners. Additionally, participants relied heavily on textbooks for content knowledge. Teacher B, in particular, displayed a gap in content knowledge when teaching using artifacts. The teacher did not have any artifacts to engage learners in a lesson on Mechanical Systems and Control. Therefore, it is necessary for Technology teachers to receive content development training.

#### ***Pedagogical Content Knowledge***

Participants demonstrated insufficient pedagogical content knowledge. Although they used narratives to teach the content, the scenarios were unfamiliar to learners. For example, in Teacher A's case, learners failed to understand what a motor kit is, resulting in the failure to achieve lesson objectives. Furthermore, learners would become lost as the teacher continued to narrate. Consequently, they would miss out on what they were supposed to learn during that lesson.

The lack of pedagogical content knowledge was also evident in Teacher B's case. The teacher failed to critically think about artifacts that could be used to teach content within Mechanical Systems and Control. Teachers with sufficient content knowledge can be creative and think critically about ways to transfer that knowledge.

### ***Educational Context***

Although participants made use of digital resources during teaching, both of them still required assistance from others to operate these resources. As a result, teachers may not be considered to have sufficient knowledge of the use of educational devices since they have not gone beyond using laptops and projectors.

### ***Knowledge of Learners and their Characteristics***

The participants' classes consisted of learners with autism, intellectual difficulties, and behavioral disorders, who were considered special needs learners. However, participants demonstrated insufficient knowledge of learners and their characteristics, as they failed to effectively engage learners throughout the lessons. For instance, Teacher A continued to replay the animation (video) without realizing that an autistic learner was already bored. Similarly, Teacher B failed to provide proper guidance to an intellectually challenged learner during a lesson involving the use of laptops.

## **CONCLUSION**

The purpose of this study was to investigate effective teaching strategies for instructing grade 9 learners with special needs in Mechanical Systems and Control. Shulman's (1987) Pedagogical Content Knowledge served as a framework to guide the study. The study found that Technology teachers lacked specific creative teaching strategies for teaching learners with special needs in all Mechanical Systems and Control lessons. Additionally, the study revealed that Technology teachers' pedagogical content knowledge was questionable, as they demonstrated limited knowledge about teaching learners with special needs, including knowledge of learners and their characteristics. Consequently, these teachers struggled to engage learners in the lessons, particularly those with autism who required creative strategies to increase their attention span.

Furthermore, when examining how Technology teachers creatively taught Mechanical Systems and Control to learners with special needs, the study discovered that grade 9 Technology teachers did not effectively employ a variety of teaching strategies. Although teachers utilized digital resources, narrative discourses, textbooks, and artifacts, these techniques were not consciously used to ensure that all learners comprehended the presented concepts. For instance, learners who were visually impaired could not clearly see the projected slides and those who had textbooks struggled to understand instructions. Moreover, the narrative discourses used by teachers did not relate to the learners' real-life experiences, thereby hindering active learning.

## **RECOMMENDATION**

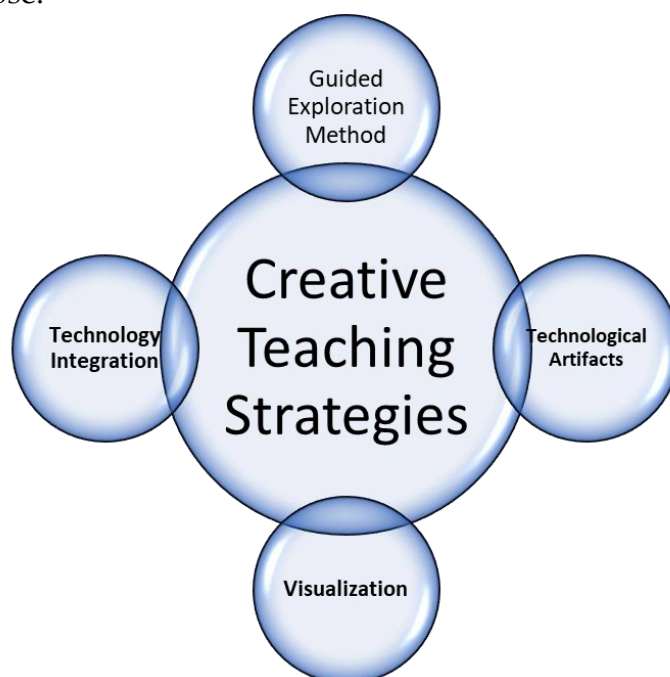
Based on the findings of this study, the following recommendations are proposed to support teachers of learners with special needs in developing innovative teaching strategies for teaching mechanical systems and control.

1. Technology teachers should receive urgent training in the form of Continuous Professional Development (CPD) to enhance their knowledge and understanding of their Pedagogical Content Knowledge (PCK).
2. Technology teachers possess knowledge about various digital technologies that can be utilized for instruction; however, they lack creative methods to engage learners with autism throughout the lesson. It is recommended that teachers be supported

by teacher assistants who specialize in meeting the diverse needs of learners with special needs.

3. Many Technology teachers are unaware of the teaching methods they typically employ in their classes. Therefore, it is recommended that all teachers receive training in the utilization of the methods outlined in Figure 1, which are specifically tailored for teaching learners with special needs.

Each of the strategies outlined in Figure 1 is further explained below, to ensure that teachers, policymakers, and researchers have a clear understanding of their content and purpose.



**Figure 1.** Creative teaching strategies. Created by the author

#### Author Contributions

EKK is the principal author of this study having done extensive research on the issue of teaching learners with special learning needs. TIM and MSR contributed equally to this offering as advisors to EKK. All authors have read and agreed to the published version of the manuscript.

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#### Conflict of Interests

The authors declare no conflict of interest.

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