AFRICAN PERSPECTIVES OF RESEARCH IN TEACHING AND LEARNING
ISSN PRINT: 2521-0262
ISSN ONLINE: 2662-012X

Teaching Mechanical Systems Practical Assessment Task Through 9E Instructional Model in a Technology Senior Phase Classroom

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ABSTRACT

Technology teachers should be acquainted with various instructional models that enable skills transfer with ease. This is because Technology is a skills-based subject that requires specialized didactic models to teach learners mechanical, electrical, and structural skills. The purpose of this study was to examine how Technology teachers use the 9E- instructional model to teach Practical Assessment Tasks (PAT). As a result, this study used the 9E instructional model as its framework to assist in showcasing the phenomenon. A constructivist approach was also used to undergird the focus of this study. The study employed a qualitative research approach using an exploratory design to gather non-numerical data. A total of four Technology teachers who were teaching the Technology subject were purposively sampled and observed. The researcher used field notes to capture the activities that were unfolding in the classroom. Observation schedules were also developed to elicit important information. The findings of the study revealed that teachers were able to elicit learners' baseline knowledge, they could not elaborate on some mechanical concepts, make connections of content with real-life examples and exchange PAT ideas. Teachers were unable to facilitate the design, make and communication stages. It was then recommended that teachers use a 9E instructional stages to augment their practical teaching skills.

Keywords: Technology, Constructivism, 9E instructional model, Practical Assessment Tasks, IDMEC.

INTRODUCTION

In the history of teaching Technology senior phase, a lot of suggestions have been made to assist teachers to capture important stages of teaching practicals. For instance, Makhubele et al. (2019) posit that constructivist learning theory and active learning techniques have the greatest potential to improve learner participation during practical lessons. Also, Mtshali and Singh-Pillay (2023) suggest that a pedagogical capital model is the most effective strategy to teach practical's.

These scholars claim that each teacher should bring a certain pedagogical capital to be able to make sense of how learners learn particular skills. Interestingly, the pedagogical capital model is silent on practical pedagogical knowledge which would enable teachers to engage effectively with Practical Assessment Task (PAT). On account to this, this study delves into an instructional approach that can assist teachers not only to elicit prior knowledge, but to also engage, explore and exchange ideas with learners as they engage with PAT. 9E instructional model has been commended to activate all necessary lesson moments in the classroom, thereby making it easy for teachers to teach Technology with ease. it is common knowledge that Technology teachers are central to learners' skills acquisition hence a need to come up with teacher-learner interactive model. As a consequence, this study sought to use 9E instructional model to understand how

technology teachers facilitate the design process skills in a constructive manner.

Seemingly, since the inception of Technology subject in schools, a lot of confusions with regards to teaching, learning and assessment continues each day. There is an urgent need to close such confusion particularly when more learners are flocking to the Technology discipline. We cannot afford to still be entertaining lingering teacher misconceptions about the subject. As a result, it follows to consider giving a brief about the development of Technology subject within the South African school's curriculum. This is with hope to create an all-inclusive understanding of why 9E instructional model would be suitable for implementation in all practical activities in a Technology classroom. Technology education was introduced in 1998 as a separate learning area in a new curriculum (Department of Education [DBE] , 2008). The introduction of the new curriculum called Outcomes Based Education (OBE) in 1998, was initiated to replace a different curriculum that was established during the apartheid era (Jansen, 1998). However, it was accompanied by serious challenges that led to its revision and the introduction of the National Curriculum Statement (NCS) in 2002 (Makgato & Ramaligela, 2012). The introduction of the revised curriculum initiated other challenges and it was also revised to a new curriculum called Curriculum and Assessment Policy Statement (CAPS) (Badugela, 2012). Those challenges include but are not limited to inadequate resources, financial constraints, and the lack of training (Badugela, 2012).

The NCS remains a policy, while the new CAPS give clear guidelines for the implementation of the NCS (De Jager, 2011). The reconstruction of NCS was used to strengthen and provide clear guidelines on how Technology teachers must facilitate PATs. In NCS the term continuous assessment task involves informal and formal assessments. The new curriculum document was improved, and it was referred to as CAPS. The CAPS has been structured in such a way that the investigation, design, making, evaluation, and communication (IDMEC) is a backbone or the methodology of teaching the four-content knowledge (DBE, 2011). The teaching of Technology is structured through the design process to facilitate the entire process, as the teachers facilitate the process (De Jager, 2011). The design process in Technology is a series of steps that the technology teachers facilitate to learners as they solve problems (DBE, 2011).

RESEARCH PROBLEM

The design process forms the backbone of teaching Technology to engage learners in a systematic process aiming to develop solutions to problems, and it should be used to structure the delivery of all the learning outcomes. The technological design process involves the integrated process of making a product or prototype. However, during various DBE training and workshops, most teachers have raised the issues of not having formal training in the Technology subjects and they find it difficult to facilitate the design process skills. They alluded that they cannot facilitate the PAT in Technology and transfer the knowledge to the learners adequately. In essence, teachers are having difficulty in teaching hands-on practical activities due to the lack of adequate technical skills and pedagogic content knowledge. Their comments raise questions since Technology teachers are expected to facilitate the PAT for each Technology concept. Patricia, Isaac and Manto's (2022), findings revealed that grade 9 Technology teachers find it challenging to be creative when teaching PAT. Therefore, if the teachers do not have thorough skills to facilitate PAT, they will not be able to facilitate the Technology content knowledge. This is a problem because teachers will eventually focus more on the theory section than the practical section. As indicated before, the Technology subject is a practical based subject that requires the learners to apply hands-on skills. If teachers do not provide practical lessons, learners will not

have adequate skills in Practical Assessment Tasks. Hence this gap motivated the researchers to understand the Technology teachers' ability to facilitate the design process skills. The study give emphasis on how grade nine (9) Technology teachers facilitate Practical Assessment Task in their classrooms. The results of the study can be used as information to develop teachers in facilitating practical assessment tasks within the context of reforming Curriculum Assessment Policy Statement (CAPS) for Technology education in General Education and Training (GET). Information collected will help in coming up with strategies for Technology teachers to facilitate PAT. Therefore, the analysed results of this study serve as a secondary source to the identified gap and provide solutions that a new generation of research in this area needs to address.

The research and information containing teachers' ability to facilitate PAT in Technology is not widely researched. Guide on facilitating PAT or artefact have been lacking in Technology education and little has been done on how facilitation on artefacts has been done.

CONCEPTUAL FRAMEWORK

This study used Amineh and Asl's (2015) theory of constructive teaching and adopted the 9E Instructional model as purported by Ramaligela, Ogbonnaya and Mji (2019) to explore how Grade 9 Technology teachers facilitate PATs in the classroom. According to Amineh and Asl (2015), the theory of constructive puts more emphasis on teaching as a system where teachers need to create situations that challenge the assumptions of traditional teaching to constructive teaching. Shah (2019), views constructivist teaching as the fundamental process constructivist learning theory where learning occurs when the learners are actively involved in a process of meaning and knowledge construction. A constructive teacher engages learners in the process of learning and guiding them (Amineh & Asl, 2015).

Shah (2019) further explains that the constructivist teacher is a facilitator who considers the learners' needs and encourages peer interaction. Mabasa et al. (2023) indicate that the teacher should create situations in which the learners will question their own and each other's assumptions and build new knowledge through exploring and reflecting to form new ideas. This theory is relevant to this study since the Technology subject requires engaging in each assessment task in a constructive approach where the learners are required to explore, question their assumptions, and reflect on various issues to build new knowledge. Therefore, constructive teaching in this study refers to the interactive transfer of ideas between the teacher and the learners. Hence, this study sought to explore how the teachers facilitate PATs in their classrooms through the lens of a constructive system.

Although the constructivist theory may be more relevant as a lens in this study, it does not fully allow the researcher to understand how each activity is facilitated in a constructive manner. To understand the teacher's constructivist teaching system in each activity, the study proposes the 9E instructional model. Ramaligela et al. (2019), proved that the 9E instructional model can be used to evaluate classroom instructional activities. Hence, this study will use the 9E instructional model to understand how technology teachers facilitate the design process skills in a constructive manner. The 9E instructional model is compatible with the Technology IDMEC design process. The phases that were adopted from the 9E are elicit, elaboration, engagement, enlightening, enclosure, explanation, exploration, exchange and evaluation because they remain relevant to constructive theory to facilitate the PAT. In each phase learners where actively involved in the activities (Sha, 2019). Learners were engaged in the entire IDMEC process (Amineh & Asl, 2015). The study conducted by (Ramaboea et al., 2022)

to explore the influence of the 9E on grade 9 Technology teachers when facilitating the design process in the classroom. The study found that most teachers where able to facilitate the PATs through the 9E (Ramaboea et al, 2022). The study conducted by Ramaligela (2021), on exploring pre-service technology teachers' content and instructional knowledge when using the 9E model found that the content and instructional knowledge displayed by most pre-service Technology teachers was inadequate.

Facilitating the Mini-PAT in technology education subject in constructivist classroom

The Technology subject has four content knowledge aspects, that is, structures, processing, mechanical systems, and control as well as electrical system and control. The teaching of the content areas requires a teacher to possess (1) Knowledge of the subject matter, and (2) Knowledge of making products which includes knowledge of investigation, design, making of a product, evaluation of the product, and communicating the product. According to Kubheka (2018), this is specialised knowledge that teachers need to have before designing any product. According to Rauscher (2016), most of the teachers in South Africa were not trained to teach Technology but were transferred from other learning areas to teach this new subject. Based on the two arguments, this study sought to understand how Technology education teachers facilitate this PAT.

Since the introduction of Technology in the new curriculum framework based on outcomes-based education, many teachers find it difficult to apply alternative ways to enhance teaching in classrooms (Janak, 2019). Janak (2019) argues that teachers are resistant to the use of technology resources to facilitate the MINI-PAT due to the lack of technology skills and knowledge. In contrast, Nkosi and Adebayo (2021) find that the teaching and learning were mainly constrained by the non-availability or the limited learning and teaching materials. However, the findings of the study conducted by Chiliba (2019) indicate that Grade 9 Technology teachers promote critical thinking skills in their teaching of the design process. According to (Makhubele, Simelane-Mnisi and Makgato (2019), it is important that technology learners are provided with practical skills by applying the design process. In active learning, the teachers are afforded opportunities to practice real-life situations that are similar to what the learners will experience in the classroom (Hinton, 2020). However, most teachers experience challenges in the provision of material and equipment to engage learners in activities (Ramaboea et al, 2022).

Mtshali (2020) states that the PAT should not ignore these aspects of critical thinking. Makhubele et al. (2019) further argue that teachers have a limited understanding of critical thinking. In addition, the authors find that the lack of resources hinders critical thinking skills when teaching the design process and the teachers only use textbooks to facilitate and set activities. Hence, the study conducted by Mtshali, Ramaligela and Makgato (2020) shows that most teachers use textbooks and previous examination question papers to teach their lessons. Ramaboea et al. (2022), find that most teachers who struggle to teach Technology do not have a Technology background. In addition, Patricia et al. (2023), indicate that the limitation of creative pedagogy background hinders learners' creativity.

In the constructivist approach, the teacher emphasises that the learners must retain and apply knowledge to a larger real-life context that stimulates the learners to reflect, organise, analyse, and solve problems (Ankiewicz, 2021). Groves (2021) asserts that the teachers' continuing use of the transmission style pedagogy does not use the technological material in the classroom as compared to the teachers with constructivist pedagogy techniques.

According to Ankiewicz (2021), teachers are expected to implement technology education without adequate pedagogical training. Hence, the teachers have to be equipped with the necessary skills and knowledge to teach technology education (Ankiewicz, 2021). The study conducted by Ankiewicz (2021) shows that the teachers were not sure how to facilitate the teaching of Technology in the classroom. Ankiewicz (2021) says the lack of appropriate resources (classrooms, workshops, tools, equipment, materials) becomes a challenge on how to facilitate the Technology classroom. In contrast, Isaac and Manto (2019) highlight how the availability of resources for practical skills does not assure the effectiveness of the skills gained in the Technology classroom.

According to Ankiewicz (2021), Technology education was introduced as a successor to various forms of craft or technical education, and it has held challenges for the teachers who were responsible for the implementation of technology. However, Janak (2019) says that not all Technology teachers adopt a student-centred approach to teaching Technology. Kola, Rauscher and Haupt (2019) state that technology teachers have a challenge of translating and employing critical thinking skills in the Technology classroom. Kola et al. (2019) further highlights that teaching technology in the classroom is restricted. Ankiewicz (2021) argues that Technology is a technical subject, and it requires teachers to be well-trained in different technology themes and in different materials. Hence, the lack of teachers' confidence, the incompatible pedagogical approaches and the restrictive curricula are also challenging to most technology teachers (Gumbo, 2019). The study conducted by Kola (2021) on the pre-service teachers' action research indicates that both pre-service and established teachers experience difficulties when developing learning activities in Technology Education. However, the study conducted by Janak (2019) on the Technology teachers' perspectives on the technology curriculum brings a wider perspective of the challenges that the technology teachers must execute in the Technology classes.

Understanding the constructive teaching theory through the 9E instructional model

As indicated earlier, Technology subject is a constructive rich approach subject, thus it is important to align our lens with a constructive teaching theory. According to Amineh and Asl (2015) constructive theory of teaching advocate for a personal construct system where the teacher develops and enforces situations that challenge the assumptions of traditional teaching to constructive teaching. Shah (2019) posits that constructivist teaching occurs when learners are actively involved in a process of meaning and knowledge construction. According to Amineh and Asl (2015) adds that teachers must engage learners in learning, and guiding, as well as consider the learners' prior knowledge.

Shah (2019) further explains that the constructivist teacher is a facilitator who considers the learners' needs and encourages peer interaction. Interestingly, Amineh and Asl (2015) avers that teachers should create situations in which the learners will question their own and each other's assumptions and build new knowledge through exploring and reflecting practices. As a result, this study found this theory relevant on account that Technology subject requires engagement in each assessment task where learners are required to explore, question their assumptions, and reflect on various issues to build new knowledge. Therefore, constructive teaching in this study refers to the interactive transfer of ideas between the teacher and the learners. Hence, this study sought to explore how the teachers facilitate PATs in their classrooms through the lens of a constructive system.

Although the constructivism theory may be more relevant as a lens in this study, it does not fully allow the researcher to understand how each activity is facilitated in a constructive manner. To understand the

teacher's constructivist teaching system in each activity, the study proposes the 9E instructional model. Ramaligela, Ogbonnaya and Mji (2019), Technology subject requires engaging in each assessment task in a constructive approach where the learners are required to exploration, questioning of assumptions, and reflection on various issues to build new knowledge is paramount. Thus, constructive teaching in this study refers to the interactive transfer of ideas between the teacher and the learners.

This study used the 9E instructional model to understand how technology teachers facilitate the design process skills in a constructive manner. The phases of the 9E instructional model as conceptualised by Ramaligela et al. (2019) are compatible with the Technology IDMEC design process. The phases adapted from the 9E Instructional model are elicit, elaboration, engagement, enlightening, enclosure, explanation, exploration, exchange and evaluation.

RESEARCH QUESTIONS

1. How do grade 9 Technology Teachers facilitate PAT using the 9E model in Technology classrooms?
2. How do grade 9 Technology teachers facilitate the PAT in constructivist classrooms?

RESEARCH METHODOLOGY

A qualitative research approach was used in this study to gather non-numerical data while focusing on meaning-making and on human elements (Denzin & Lincoln, 2005). The study selected four Technology teachers. The study was positioned on Stakes's (1995) perspective of case study to seek in-depth understanding of the case. The four teachers participated in the non-participant observations of lessons. The four lessons observed by were analysed through deductive analysis. The study further discussed the findings to understand how the teachers employed the theory of constructive teaching in their classroom practice. The themes and the categories from the field notes were used to understand the teachers' mode of facilitating the PAT and to present data.

Population

Shukla (2020) defines a population as a set or group of all the units on which the findings of the research are to be applied. The population of the study comprised of the Grade 9 Technology teachers in the Waterberg district as the researcher sought to understand the teachers' concerns (Casteel & Bridier, 2021). The Waterberg district has 149 schools and 15 circuits. Palala is one of the circuits and it has 23 high schools.

Sampling

This study used purposive sampling because it allowed the researcher to select the participants based on the specific purpose of aiming to address the study purpose (Creswell, 2018; Carol & Iben, 2014). This study selected ten schools offering technology education where four technology teachers participated for observation (Carol & Iben, 2014). The four teachers who were chosen for observation were purposively sampled, the researcher wanted to observe two teachers who indicated that they were having challenges when facilitating PAT and two teachers who indicated that they have limited challenges since the researcher wanted to observe when facilitating the PAT.

Data collection technique

Non-participants observations

In non-participant observation, the researcher was on the outside looking, and not taking part in the classroom practice (Busetto, Wick & Gumbinger, 2020). This study used non-participant observations because the researcher was not involved in the teaching (Ciesielska, Boström & Öhlander, 2018). The non-participant observation method was used to explore how the Technology teachers facilitated PAT in their classrooms because the observation enabled the researcher to gather enough information on a wide range of phenomena (Ciesielska et al., 2018). The researcher used

field notes to capture the activities that were unfolding in the classroom since videos or visuals are prohibited in most schools. Furthermore, the observation schedules were developed to elicit important information that was used to answer the research question. As indicated earlier, the study used the 9E instructional model as a conceptual framework for this study, and it was used as a guide to develop an observation schedule.

Data analysis

The lessons observed from the four participants were analysed through deductive analysis. According to Azungah (2018), a deductive analysis requires a structured or predetermined approach. The researcher used field notes where the activities that were unfolding in the classroom were captured, and the observation schedules were developed to elicit important information that was used to answer research question.

The notes were manually transcribed into a narrative story text form, quoting the exact events that took place during classroom practice (Creswell, 2018). The study analysed the data according to the themes that were drawn from the 9E instructional model, and the categories were drawn from the IDMEC process. It further discussed the findings to understand how the teachers employed the theory of constructive teaching in their classroom practice. The themes and the categories from the field notes were used to understand the teachers' mode of facilitating the PAT and to present data.

SIGNIFICANCE OF THE STUDY

This study identified how Grade 9 Technology teachers used the 9E instructional model to facilitate PATs in their classrooms. This is an area that has not been fully investigated in the South African education system. The results of the study can be used as a basis to develop the teachers in facilitating practical tasks within the context of reforming the CAPS for technology education in General Education and Training (GET). The collected information will help in coming up with the strategies for the Technology teachers to facilitate the PATs. Therefore, the analysed results of this study serve as a secondary source to the identified gap, and they provide the solutions that a new generation of research in this area needs to address.

DISCUSSION AND RESULTS

As a reminder, this study was concerned with understanding how Technology Teachers facilitate PAT using the 9E model in Technology classrooms. Thus, the findings below details how the lesson unfolded in line with the 9E instructional model tenets.

During Elicit phase- two teachers were able to elicit the learners' prior knowledge while the other two teachers were unable to elicit learners' prior knowledge. During observation, two teachers elicited the learners' prior knowledge during the investigation stage and the other two teachers elicited the learners' prior knowledge during the design stage. However, only one teacher was able to elicit the learners' prior knowledge during the making and evaluation stages.

During the Elaboration phase- two teachers were able to connect everyday experiences with the topic during the investigation and evaluation stages. However, all the teachers were not able to do this in the design stage. The data revealed that only one teacher was able to connect everyday experiences to the topic in the making stage. The observation further revealed that two teachers were able to support the learners to use tools and build and test the product during the evaluation stage. The data revealed that all the teachers were not able to support the learners in using tools, build and test the product during the design and the making stages.

During the engagement phase- four teachers were able to keep the learners

as active participants in the investigation and communication stages; three teachers did this in the evaluation stage and only one teacher was able to keep the learners as active participants in the design and making stages. Therefore, only one teacher was able to keep the learners active in all the designing stages.

During the enlightening phase- two teachers were able to relate different concepts to the topic when facilitating the investigation and during the making stages. However, the other two were not able to relate the different concepts to the topic when facilitating the design and making stages. The data revealed that only one teacher was able to relate the different concepts to the topic when facilitating the designing and making stages. The data indicates that most teachers have a challenge in relating the different concepts to the topic in technological processes.

During the enclosure phase- two teachers were able to summarise the concept during the evaluation stage and three teachers were able to summarise the concept during the communication stage. However, only one teacher was able to summarise the concept during the investigation and the design stages. The data revealed that all the teachers were unable to summarise the concept during the making stage.

During the explanation phase- three teachers were able to facilitate different concepts to enhance the learners' understanding during the investigation and evaluation stages. However, only one teacher was able to facilitate different concepts during the design and the making stages. The data revealed that most teachers have challenges in facilitating different concepts in most technological processes.

During the exploration phase- two teachers were able to introduce new concepts to the learners when facilitating the investigation and evaluation stages.

During the exchange phase- all the teachers were able to use the learners' ideas during the evaluation stage. However, only one teacher was able to use the learners' ideas during the investigation and the design stages. The data revealed that all the teachers were not able to use the learners' ideas during the making stage.

During the evaluation phase- three teachers were able to evaluate the learners' decisions and problem-solving techniques during the evaluation stage. However, only one teacher was able to evaluate the learners' decisions and problem-solving techniques during the investigation stage. The data revealed that all the teachers were not able to evaluate the learners' decision and problem-solving techniques during the design and the making stages. The data indicates that most teachers have challenges in evaluating the learner's decision and problem-solving techniques in most technological processes (IDMEC).

LIMITATIONS

The study employed the qualitative research method, focusing on meaning-making and on human elements. The study employed the case study design. Observation was the only tool that was used to collect data. Hence, the Grade 9 Technology learners have a greater proportion of the entire school enrolment in most secondary schools. Most schools were subjected to rotational class attendance due to the Covid-19 regulations. The researcher was limited to observing the permissible capacity per class under unusual conditions. The interviews were preferably done face to face by most participants despite the geographic spread of the 23 schools which required more time to assess the participants. Due to the lack of funds, the study was confined to the Palala circuit schools, meaning only the 10 schools within the Palala circuit were sampled and this led to sampling only rural schools.

CONCLUSION

The study explored the Grade 9 Technology teachers facilitate the PAT in the constructivist technology classroom. As

indicated earlier, the researcher observed four teachers. The study found that the teachers were unable to facilitate the design, make and communication stages. Hence, this study concludes that most of the teachers experience challenges when facilitating the PATs in the classroom. The study further found that most of the teachers who struggle to teach Technology education lack a Technology background. Teachers find it difficult to implement constructivism to facilitate the design process in the Technology classroom.

RECOMMENDATIONS

The teachers should be familiarised with how to facilitate the PAT through the design process in a constructivist classroom. The teachers should be developed on how to engage the learners in activities, and on how to make material and equipment accessible to the learners during activities. There is also a need to learn how to use topic-specific strategies to relate the content with the learners' real-life experiences and to connect the learners' everyday experiences with the content. There is a need to provide clear explanations that limit misconception, on how to summarise the concept and how to use the learners' ideas to identify and correct misconceptions. Most importantly, the Technology subject should be taught by teachers based on their expertise in teaching Technology education. The results of this study will help in coming up the strategies for the Technology teachers to facilitate the PATs. Therefore, serves as a secondary source and provide solutions that new researchers in this area needs to address.

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