DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES IN HONOURS PROGRAMME IN A SOUTH AFRICAN UNIVERSITY

by

PRAYGOD BONGINKOSI NKOSI

THESIS

Submitted in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

TECHNOLOGY EDUCATION

in the

FACULTY OF HUMANITIES

at the

UNIVERSITY OF LIMPOPO

SUPERVISOR: PROF. SM RAMALIGELA

2025

DEDICATION

This research study is dedicated to everyone who wants to improve instruction and learning within the fields of Technology Education. The following individuals who I cherish deeply are also honoured by its dedication:

- My mother, Thandi Sibongile Shabangu: *Ngiyabonga "Mbhele" imithandazo yakh' ingibeke langikhona namuhla.*

- My wife, Nonhlahla Cythia Nkosi: Thank you for persevering during the late nights, early mornings, and away retreat writings.

- My children, Zwelihle, Lukhanyo, Amahle, and Khwezi: I know I was not always available; thank you for always understanding.

- My siblings, Vivian, Nicholas, Nontokozo, and Portia: You are always there for me, thank you. After all, "blood is thicker than water".

DECLARATION OF ORIGINALITY

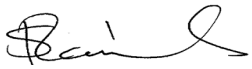
I, Praygod Bonginkosi Nkosi, Student Number [redacted], hereby declare that "Developing Technology Teachers' Creative Teaching Skills Through the Integration of Educational Technologies in Honours Programme in a South African University" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

Doctoral student: Nkosi, PB

Signature:

Date: 07/11/2024

Supervisor: Professor Ramaligela, SM

Signature: 

Date: 07/11/2024

ACKNOWLEDGEMENTS

Simakadze lophumelelisa maphupho ludvumo lonkhe kuwe. Angentanga ngewam' emanadla. You are my strength and guiding light always … Amen!!!

I would like to express many thanks to the following individuals who contributed to the completion of this thesis:

- Prof. Manto Sylvia Ramaligela: You were more than a supervisor for me. *A thina maipfi a u vha livhuwa kha mushumo we vha nnyitela wone, mudzimu nga vhe a tshi vha engedzela maduvha a vhu tshilo havh.* Thank you for keeping the flame going and bringing me to light. I could not have navigated through this journey without your guidance. I have no reservations about the professional and research skills you have furnished me with. You have indeed led the academic community. I honour you and give thanks to God Almighty for allowing me to work near you so you could mentor me carefully during this academic journey. *"Uyimbokodo" vha musadzi vhukati ha vhasadzi kha zwa pfunzo".*
- To my true bother and friend, Xolani Timothy Mabila, and family "Warra": Thank you for your unwavering support. If I were to tell my success story, surely you will be the main character. *Umusa waNKhulukhul' ube nawe ngato tonkhe tikhatsi*. More life, more success, and more blessings.
- To my brother and mentor, Dr Thembinkosi Mabila, and family: Without your mentorship, I would have not made it this far in academia. Therefore, I will be forever grateful. Thank you and God bless you "Solani''.
- To my colleagues and friends in academia: To Dr Thokozani Isaac Mtshali – *ngiyabonga nsizwa, izandla zidlula ikhanda*. To Mr Lusanda Ncisana – *ndiyabulela mtanekhehla, umbulelo wam' awunakulinganiswa*. Having you both in my academic journey was a true blessing.
- To Prof. TN Mafumo: Thank you for your guidance and support throughout my studies.
- To the Research Office and the PhD cohort at the University of Limpopo: Thank you for the support.
- To family and friends: Thank you for your undying support in always encouraging me to complete my academic journey.

ABSTRACT

The advancement of technology continues to significantly influence classroom practices, modifying the ways in which teaching, and learning occur. However, many teachers are often left behind in this transformation, resulting in feelings of demotivation, frustration, and a sense of being outdated particularly in issues relating to the integration of Educational Technologies. To bridge this gap, it is imperative for the Ministry of Education to ensure that teachers are up to date with emerging technological developments that have the potential to enhance classroom teaching and learning. Achieving this requires the implementation of continuous professional development initiatives, such as targeted training programmes, workshops, and seminars, to equip teaches with the necessary knowledge and skills to effectively integrate technology into their classroom practices. Therefore, teachers must inevitably rise to the challenges by gaining the knowledge necessary to use Educational Technologies in the classroom effectively. Moreover, the importance of making the education and training systems receptive to the demands of the new skills needed to navigate a more technologically driven world cannot be stressed enough.

This study aimed to explore the development of Technology teachers' Creative Teaching Skills by integrating Educational Technologies in a Senior Phase classroom. The enquiry was conducted among a sample of Honours students in a South African University, with most students practising as Technology teachers. Qualitative methods were engaged to obtain data from group interviews before and after the intervention programme, semi-structured interviews, document analysis, and non-participant observation. Data were analysed using qualitative content analysis to understand how teachers develop their Creative Teaching Skills through integrating Educational Technologies.

The findings were multi-fold. First, teachers do not regularly use Educational Technologies as expected in the digital age, possibly due to various influencing factors. Second, there is a lack of knowledge and skills among teachers regarding the integration of Educational Technologies into their teaching. Third, Creative Teaching Skills can be enhanced through targeted professional development

programmes. Fourth, inadequate ICT infrastructure and limited resources in schools hinder effective integration of Educational Technologies. Finally, the absence of clear policies on ICT infrastructure and resources further restricts teachers from fully leveraging Educational Technologies. These significant findings suggest that teachers developed Creative Teaching Skills, gained experience, and transformed classroom practice. Teachers' viewpoints on integrating Educational Technologies were fortified with knowledge and facts as they gained insights while participating in the intervention programme.

Keywords: Educational Technologies, Creative Teaching, integration, creative lesson

TABLE OF CONTENTS

DEDICATION ii

DECLARATION OF ORIGINALITY iii

ACKNOWLEDGEMENTS iv

ABSTRACT v

TABLE OF CONTENTS vii

LIST OF FIGURES xv

LIST OF TABLES xvi

LIST OF ABBREVIATIONS xvii

CHAPTER 1: GENERAL INTRODUCTION TO THE STUDY 1

1.1 INTRODUCTION 1

1.2 RESEARCH PROBLEM 3

1.3 DISCIPLINE SPECIFIC TECHNOLOGIES FOR SENIOR PHASE TECHNOLOGY TEACHING 4

1.4 PURPOSE OF THE STUDY 7

1.4.1 Objectives of the study 8

1.4.2 Research questions 8

1.5 THEORETICAL FRAMEWORK 8

1.6 RESEARCH METHODOLOGY 9

1.7 SIGNIFICANCE OF THE STUDY 10

1.8 ETHICAL CONSIDERATIONS 10

1.8.1 Permission for the study 10

1.8.2 Informed consent 10

1.8.3 Anonymity/Confidentiality 11

1.8.4 Voluntary participation 11
1.8.5 Respect for participants' dignity 12
1.8.6 Privacy 12
1.8.7 Data storage and access 12
1.8.8 Potential benefits to participants 13
1.9 EXPLANATION OF KEY TERMS 13
1.10 OUTLINE AND ORGANISATION OF THE STUDY 14
1.11 SUMMARY OF THE CHAPTER 16
CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK 17
2.1 INTRODUCTION OF THE CHAPTER 17
2.2 INTEGRATION OF EDUCATIONAL TECHNOLOGY IN THE CLASSROOM 17
2.3 UNDERSTANDING CREATIVE TEACHING IN CLASSROOM PRACTICE 19
2.3.1 Creative Teaching with Educational Technologies 20
2.3.2 Teachers' use of Educational Technologies to design and present creative lessons 22
2.3.3 Teachers' use of Educational Technologies to design creative activities ……23
2.3.4 Social Constructivism as an approach for teaching and learning 24
2.3.5 Teachers' views of the impact of Educational Technologies on preparing creative lessons and activities 25
2.3.6 Teachers' attitude on the integration of Educational Technologies 26
2.3.7 The integration of Educational Technologies within the Social Constructivist Approach 27
2.3.8 Instructional strategies for Creative Teaching 28
2.4 CREATIVE TEACHING APPROACH THROUGH THE LENS OF SOCIAL CONSTRUCTIVISM 29

2.5 SUMMARY OF THE CHAPTER 35
CHAPTER 3: RESEARCH METHOLODOLOGY AND DESIGN 36
3.1 INTRODUCTION OF THE CHAPTER 36
3.2 PARADIGMATIC APPROACH 37
3.2.1 Ontology 37
3.2.2 Epistemology 38
3.3 RESEARCH APPROACH 38
3.4 RESEARCH DESIGN 39
3.5 STUDY SETTING 43
3.6 POPULATION AND SAMPLING 43
3.7 DATA COLLECTION 44
3.7.1 Pre and post the semi-structured group interview 45
3.7.2 Document analysis 45
3.7.2.1 Lesson design 46
3.7.2.2 Activity design 46
3.7.3 Non-participant observation 47
3.7.4 Semi-structured interviews 48
3.8 DATA ANALYSIS 48
3.8.1 Analysis of data pre and post the semi-structured group interviews 49
3.8.2 Analysis of lesson plans 49
3.8.3 Analysis of activity design 50
3.8.4 Analysis of non-participatory observations 52
3.8.5 Analysis of semi-structured interviews 52
3.8.6 Presentation and discussion of the data 53
3.9 QUALITY CRITERIA 55

3.9.1 Credibility 55
3.9.2 Transferability 55
3.9.3 Dependability 56
3.9.4 Confirmability 56
3.10 ETHICAL CONSIDERATIONS 56
3.10.1 Permission for the study 57
3.10.2 Informed consent 57
3.10.3 Anonymity/Confidentiality 57
3.10.4 Voluntary participation 58
3.10.5 Privacy 58
3.10.6 Access and storage 58
3.10.7 Potential benefits to participants 59
3.10.8 Respect for participants' dignity 59
3.11 SUMMARY OF THE CHAPTER 59
CHAPTER 4: PRESENTATION AND DISCUSSION OF FINDINGS FOR RESEARCH QUESTION 1 AND 2 60
4.1 INTRODUCTION OF THE CHAPTER 60
4.2 TEACHERS' PROFILES 60
4.3 WHAT ARE THE TECHNOLOGY TEACHERS' KNOWLEDGE AND UNDERSTANDING OF VARIOUS EDUCATIONAL TECHNOLOGIES AND APPROACHES USED IN DESIGNING AND PRESENTING CREATIVE LESSONS BEFORE AND AFTER TRAINING? 62
4.3.1 Group interviews pre intervention 62
4.3.2 Group interviews post intervention 69
4.3.3 Summary 74
4.4 WHAT ARE TEACHERS' PERCEPTIONS OF THE IMPACT OF

EDUCATIONAL TECHNOLOGIES ON THE UNDERSTANDING AND DEVELOPMENT OF CREATIVE TEACHING SKILLS? 75

4.4.1 Summary 85

4.5 SUMMARY OF THE FINDINGS 85

4.5.1 Technology teachers' knowledge and understanding of various Educational Technologies and approaches used in designing and presenting creative lessons before and after training 86

4.5.2 Teachers' perceptions of the impact of Educational Technologies and their understanding and development of Creative Teaching Skills 88

4.6 SUMMARY OF THE CHAPTER 88

CHAPTER 5: PRESENTATION AND DISCUSSION OF FINDINGS FOR RESEARCH QUESTION 3 AND 4 90

5.1 INTRODUCTION OF THE CHAPTER 90

5.2 HOW DO TECHNOLOGY TEACHERS USE EDUCATIONAL TECHNOLOGIES TO DESIGN CREATIVE LESSONS AND CREATIVE ACTIVITIES? 90

5.2.1 Designing creative lessons and creative activities 90

5.2.3 Teachers' use of Educational Technologies to design creative lessons and activities 131

5.2.3.1 Interaction with Prior Knowledge 131

5.2.3.2 Interaction with New Knowledge 132

5.2.3.3 Construction of Own Knowledge 132

5.2.4 Summary 133

5.3 HOW DO TECHNOLOGY TEACHERS USE EDUCATIONAL TECHNOLOGIES TO PRESENT CREATIVE LESSONS? 133

5.3.1 Classroom context 134

5.3.2 Classroom observations 136

5.3.2.1 Lebrone classroom observations (School A) 137
5.3.2.2 Jude classroom observation (School B) 146
5.3.2.3 Judith classroom observation (School C) 152
5.3.2.4 Calton classroom observation (School D)..... 159
5.3.2.5 Jolie classroom observation (School E)..... 169
5.3.2.6 Kim classroom observation (School F) 176
5.3.2.7 Kevin classroom observation (School G)..... 183
5.3.3 Teachers' use of Educational Technologies for lesson presentation .. 191
5.3.3.1 Interaction with Prior Knowledge 191
5.3.3.2 Interaction with New Knowledge..... 192
5.3.3.3 Construction of Own Knowledge 193
5.3.4 Summary 194
5.4 SUMMARY OF THE FINDINGS..... 194
5.4.1 Technology teachers' use of Educational Technologies to design creative lessons and creative activities..... 195
5.4.2 Technology teachers' use of Educational Technologies to present creative lessons 197
5.5 SUMMARY OF THE CHAPTER..... 198
CHAPTER 6: CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS, AND A PROPOSED MODEL..... 199
6.1 INTRODUCTION OF THE CHAPTER 199
6.2 SUMMARY OF THE STUDY..... 199
6.3 RECOMMENDATIONS OF THE STUDY..... 201
6.3.1 Recommendations for classroom practice..... 201
6.3.2 Recommendations for policymaking and amendment 201
6.3.3 Recommendations for teacher training 202

6.3.4 Recommendations for infrastructure 202

6.3.5 Recommendations for further research 203

6.4 LIMITATIONS OF THE STUDY 203

6.5 A PROPOSED MODEL FOR DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES 204

6.5.1 Preamble and rationale for the proposed model 204

6.5.2 Factors that prevent teachers from designing and presenting creative lessons in the classroom 204

6.5.3 Department of Basic Education 205

6.5.4 Policy 206

6.5.5 ICT infrastructure and resources 206

6.5.6 Teacher Education and Training Institutions 208

6.5.7 Teacher unions 209

6.5.8 Private sector 209

6.6 PROPOSED MODEL FOR GUIDANCE ON DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES 210

6.6.1 Explanation of the proposed model 212

6.6.2 Role of the Department of Basic Education and the school 212

6.6.3 Role of Teacher Education and Training Institutions 213

6.6.4 Infrastructure development and transformation 213

6.6.5 Policy development and amendments 214

6.7 SUMMARY OF THE CHAPTER 214

REFERENCES 215

ANNEXURES 249

Annexure A: Ethical Clarence Certificate 249

Annexure B: Gatekeeper permission letter 250

Annexure C: Permission letter 251

Annexure D: Participants' informed consent form 253

Annexure E: Participants' informed consent form 255

Annexure F: Pre-intervention semi-structured group interview 257

Annexure G: Post semi-structured group interview 258

Annexure H: Document analysis (lesson plan and activity) 259

Annexure I: Observation schedule 261

Annexure J: Semi-structured interview questions 263

Annexure K: Editor's Letter 265

LIST OF FIGURES

Figure 2.1: The classification of categories for Creative Teaching 30
Figure 3.1: Two iterations of the action research process 41
Figure 3.2: Explanation of the stages 42
Figure 6.1: Creative Teaching Skills Development Model 211

LIST OF TABLES

Table 1.1: Outline and organisation of the study 15
Table 2.1: Social Constructivism Approach 34
Table 3.1: Research approach, research design, and data collection methods 37
Table 3.2: Data gathering techniques and instruments 44
Table 3.3: Document analysis 46
Table 3.4: Components of a creative lesson plan 50
Table 3.5: Components of a creative activity.....51
Table 3.6: Social Constructivism Theory categories for this study 54
Table 4.1: Participants' profiles 61
Table 4.2: Categories of Social Constructivism for lesson presentation……134

LIST OF ABBREVIATIONS

Abbreviation	Description
CTSD	Creative Teaching Skills Development model
COK	Construction of Own Knowledge
DBE	Department of Basic Education
DHET	Department of Higher Education and Training
INK	Interaction with New Knowledge
IPK	Interaction with Prior Knowledge
PKE	Public Key Encryption
QCA	Qualitative Content Analysis
TAR	Technical Action Research
TETI	Teacher Education and Training Institution
TPACK	Technological Pedagogical Content Knowledge

CHAPTER 1: GENERAL INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

Creative Teaching refers to producing original ideas and combining extant work and objects in different ways for new purposes (Kanematsu & Barry, 2016). According to Pollard et al. (2018), Creative Teaching in education is identified through its currency, multidisciplinary dimension, innovativeness, and alignment with predetermined learning outcomes. It has been argued that creativity is critical to inventive thinking in any given domain; however, many educational institutions have not placed adequate importance on it (Kaplan, 2019).

The study by Pollard et al. (2018) on Creative Teaching in science, technology, engineering, and mathematics found that Creative Teaching requires a high level of tenacity, curiosity, an appreciation of the need to explore the unknown, and strategic risk-taking. Pollard et al. (2018) suggest that to engender these characteristics, educational institutions need to foreground professional development opportunities that will capacitate their teachers with the skills that will embed their teaching with the element of surprise, captivate learners in learning activities, and highlight the possibilities that may be achieved through institutional rewards.

Similarly, the study conducted by Kaplan (2019) on teaching for creativity and the development of creativity in education found that creative development is essential in the development of human thoughts and life chances. Furthermore, creativity theories are important in supporting instruction, learning, and the elevation of teachers' understanding (Kaplan, 2019). The study, therefore, recommends that teacher training should be embedded with creativity theories to facilitate learners' overall development (Kaplan, 2019). This is the thrust of this study – to explore the relevance of the use of Educational Technologies towards improving Technology teachers' Creative Teaching Skills in the senior phase.

Lin and Wu (2016) conducted a study on the influence of web-based, creative-thinking teaching on students' creativity, learning outcomes, and educational performance. The

study found that Creative Teaching may facilitate better performance in areas such as flexibility, uniqueness, fluency, and elaboration. Moreover, Creative Teaching stimulates learners' creative potential and promotes better performance in creative thinking. The study also found that Creative Teaching, through the integration of Educational Technologies, may improve learners' creativity and ability to solve problems (Lin & Wu, 2016). Furthermore, the use of relevant Educational Technologies in Creative Teaching has the potential to stimulate teaching, make the period of teaching flexible, enable peer interaction, provide constructive criticisms, clarify problem-solving approaches, foster creative solutions, and achieve the goals of the teaching curricula (Lin & Wu, 2016).

The view of Lin and Wu (2016) on curriculum design affirms that Creative Teaching undeniably stimulates learners' ability to think creatively and helps them to formulate innovative ideas. Moreover, Creative Teaching puts forward a pragmatic idea, which encourages the infusion of theories into the teaching practice. Likewise, the teaching of creative strategies and problem-solving techniques could be included in the design of the curriculum for learners to foster the application of these skills in real-life situations. Similarly, Veerasinghan et al. (2021) found that Creative Teaching provides inherent personal fulfilment for the teacher. Veerasinghan et al. (2021) suggest that the design thinking approach fosters Creative Teaching.

Globally the extant literature is replete with studies that focus on the phenomenon and development of Creative Teaching Skills in Technology Education and education in general (Borodina et al., 2019; Henriksen et al., 2020). Although Technology Education is a developing subject in the South African curriculum, several studies have been conducted that focus on skills development and the learning area of Technology Education and education in general. For instance, Ramaligela et al. (2014) focused on exploring the use of textbooks in a Technology classroom, and Makgato (2014) concentrated on teaching and learning in Technology Education. Gumbo (2014) engaged in action research that focused on the incorporation of indigenous Technology into the teaching of Technology Education, and Mapotse (2014) focused on an emancipation paradigm underlain by the interphase of critical theory and Technology Education. Moreover, empirical studies on Creative Teaching and thinking skills have been conducted in South Africa. For example, the study by Kola (2015)

examined how teachers deploy critical thinking skills in the teaching of Technology; Goosen and Van Heerden (2017) focused on learning programming with Educational Technologies; and Meintjes and Grosser (2010) investigated creative thinking for prospective teachers. However, it must be noted that only a few studies have explored the relevance and use of Educational Technologies in improving Technology teachers' Creative Teaching Skills in the senior phase. Hence, this study aimed to focus on this and contribute to the body of knowledge through its findings.

1.2 RESEARCH PROBLEM

This study emanated from Nkosi's (2020) research study, which explored the development of Creative Thinking Skills in the Grade 9 Technology classroom. Nkosi's (2020) study revealed that teachers and curriculum implementers have inadequate knowledge about creative thinking and how it connects to the teaching of Technology. Furthermore, a lack of interest in integrating Educational Technologies to enhance the teaching and learning process effectively using creative thinking skills in Technology classrooms was identified as a challenge. The study recommended that Technology teachers acquire relevant skills and knowledge on how to harness the creative thinking potential of their learners (Nkosi, 2020). Hence, the current study sought to further this recommendation by exploring how integrating Educational Technologies into teaching may develop the Creative Teaching Skills of Technology teachers in their classroom practice.

In South Africa, a few studies have focused on Creative Teaching and Creative Thinking Skills, especially in Technology Education. For example, Meintjes and Grosser (2010) conducted a study investigating creative thinking in prospective teachers. The study found a need for Creative Teaching, and there are inherent opportunities for developing creative thinking in teachers in South Africa. Furthermore, the study indicated that contextual factors influence the development of creative-thinking abilities. Similarly, Kola (2015) conducted a study investigating how teachers actualise critical thinking skills in the Technology classroom. The study found that Technology teachers had little understanding of critical thinking and its implications. Also, they lacked the knowledge to develop critical thinking skills in learners. Goosen and Van Heerden (2017) investigated learning programming with

Educational Technologies and found that integrating Educational Technologies provides effective teaching and meaningful learning to address the challenges of ICT education. Moreover, Wheeler et al. (2002) posit that failure to continue developing more creative thinkers will threaten the survival of advanced, industrialised nations. Hence, this study aimed to explore the relevance of using Educational Technologies in improving the Creative Teaching Skills of Technology teachers in the senior-phase classroom.

1.3 DISCIPLINE SPECIFIC TECHNOLOGIES FOR SENIOR PHASE TECHNOLOGY TEACHING

The Senior Phase Technology Education subject in South Africa is structured into four core strands: Structures, Processing, Mechanical Systems and Control, and Electrical Systems and Control (DBE, 2014). Each strand can be creatively taught using Educational Technologies that align with its content and pedagogical requirements. A variety of Educational Technologies can be utilised to enhance the teaching and learning of Technology Education creatively at this level (Nkosi & Ramaligela, 2025). These include Technologies such as presentation tools, simulations, interactive smartboards, video tutorials, animations, computer-aided design, gamification platforms, virtual reality, augmented reality, and virtual laboratories (Jabeen, 2024).The integration of Educational Technologies must be carefully considered in relation to key factors such as the nature of the content to be taught, the intended learning objectives, learners' needs, and instructional strategies (Lawrence & Tar, 2018). Given the conceptual and practical demands of Technology content in senior phase, a variety of Educational Technologies can be employed to support Creative Teaching strategies that enhance learners' comprehension and retention in all the four strands. Thus, the following segment discusses the possible Educational Technologies that can play a critical role in developing one's creative and critical thinking skills in each strand.

Structures: This strand in the Senior Phase Technology curriculum focuses on developing learners' understanding of the design, construction, and stability of both natural and human-made structures (DBE, 2014). To facilitate the creative teaching of the content on structures, a teacher can use technologies such as presentation tools,

simulations and virtual labs, computer-aided design, virtual reality and augmented reality (Tai, 2023). Presentation tools (e.g., PowerPoint) can be effectively used to enhance lesson delivery by embedding videos and animations that illustrate key concepts such as types of structure (man-made/natural structures). Simulations and virtual labs enable learners to visualise forces such as tension and compression, allowing them to experiment with structural concepts without physical materials. Computer-aided design software allows learners to digitally design, modify, and analyse structures, promoting deeper understanding before engaging in physical construction (Feng & Zhang, 2022). Additionally, virtual reality and augmented reality offer deep learning experiences that support structural analysis and real-world application. Lastly, video tutorials and animations are effective tools for simplifying complex concepts such as load distribution and material properties, thereby making the content more accessible and engaging. All the above can ensure a seamless creative approach to creatively teach and learn about structures.

Processing: This strand part of the Senior Phase Technology curriculum focusing on teaching learners how raw or natural materials (such as food, textiles, wood, and metals) are transformed into usable products through various techniques and processes (Blose & Gumbo, 2024). To facilitate the creative teaching of the content on processing, the following Educational Technologies are considered relevant: presentation tools, video tutorials, simulations and virtual laboratories, as well as interactive smartboards (Tai, 2023). Presentation tools (e.g., PowerPoint) can be effectively used to enhance lesson delivery by embedding videos and animations that illustrate key concepts such as types of materials, material properties, and processing procedures (e.g., wood processing). Video tutorials (e.g., YouTube, Khan Academy, TED-Ed) serve as valuable resources for demonstrating step-by-step techniques in various processing tasks, including food preservation, sewing, and basic carpentry. These tools support visual learning and provide real-world examples, making abstract concepts more accessible. Simulations and virtual laboratories offer opportunities for learners to investigate complex topics such as food safety, material behaviour, and the effects of heat or pressure on different substances (Mathabata, Kola & Mtshali, 2022). These platforms enable learner to conduct virtual experiments that may be unsafe or impractical in a traditional classroom setting. Interactive smartboards can be

used to display process diagrams, administer interactive quizzes, and facilitate collaborative brainstorming during lessons.

Mechanical Systems and Control: This strand in the Senior Phase Technology curriculum focuses on equipping learners with foundational knowledge and skills related to mechanical systems, their components, and how they function (DBE, 2014). To facilitate the creative teaching of the content on Mechanical Systems and Control, the following Educational Technologies are considered relevant: presentation tools, simulations and Interactive software, computer-aided design software, augmented reality and virtual reality, video tutorials and animations (Nazlidou et al., 2024). Presentation tools (e.g., PowerPoint) can be effectively used to enhance lesson delivery by embedding videos embedded videos and animations to explain motion, forces, and mechanisms. Simulations and Interactive software offer the teacher to do simulations on concepts like forces, motion, levers, gears, pulleys, etc. It also helps learners visualise mechanical concepts like mechanical advantage and torque (Ndwandwe et al., 2024). Computer-Aided Design Software enables learners to design and manipulate 3D mechanical components (e.g., gears, cams). It also supports the design and make stages of the design process. augmented reality and virtual reality allow learners to interact with virtual mechanical components in 3D space. It also the teachers to facilitate immersive exploration of how mechanisms operate. Video tutorials are useful for both teacher demonstration and learner self-study. Animations offer animated explanations of concepts like gears, cranks, levers, and control systems. Useful for both teacher demonstration and learner self-study (Utaminingsih et al., 2024; Hassaan, 2014). Virtual labs it offers virtual experimentation with forces and machines. It also encourages experimentation when physical resources are limited. Interactive smartboards help teachers with drag-and-drop mechanical component simulations.

Electrical Systems and Control: This strand focuses on introducing learners to the fundamental concepts, components, and applications of electrical systems in real-life contexts. This strand aims to develop learners' understanding of how electrical systems work and how they are controlled (DBE, 2014). To facilitate the creative teaching of the content on Electrical Systems and Control, the following Educational Technologies are considered relevant: presentation tools, simulations and virtual labs,

augmented reality and virtual reality, video tutorials and animations. Simulation and Virtual Labs it assists in simulating electrical circuits and observe real-time changes. It also allows experimentation with resistors, LEDs, and switches without physical components (Schavemaker & Van der Sluis, 2025). It builds learners confidence and understanding before moving to physical models. Augmented Reality and Virtual Reality it can used to provide immersive experiences to visualise how circuits work in real-world applications. And, to explore systems like home automation, traffic lights, or electric gates through 3D environments. Videos tutorial and Animations can be used explain abstract concepts like voltage, current, and resistance through engaging visuals (Blayi et al., 2022). Break down the design process or show real-life applications of electrical systems. Interactive smartboards enable active presentations, drawing circuit diagrams interactively.

Considering the above, Technology subject teaching and learning is significantly enhanced using Educational Technologies that promote visualisation, simulation, interactivity, and hands-on experimentation (Oliveira, et al., 2019). Furthermore, the selection of technologies used to deliver a creative lesson depends largely on the teacher's experience, knowledge, and skills, as there is no single technological tool exclusively designed for a specific topic (Boonmoh et al., 2021; McCulloch et al., 2018). However, effectively integrating Educational Technologies is not a straightforward process, it requires careful planning and consideration of all relevant factors to succeed in the classroom (Hamilton, 2022). Therefore, teachers' knowledge and skills in Educational Technologies and subject area are essential for Creative Teaching of Technology.

1.4 PURPOSE OF THE STUDY

The purpose of this study is to explore the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom.

1.4.1 Objectives of the study

- To explore Technology teachers' understanding of various Educational Technologies used in designing and presenting creative lessons before and after participating in a training intervention.
- To investigate Technology teachers' perceptions of the impact of Educational Technologies on their teaching practices and their understanding of Creative Teaching Skills and impacts the learners learning.
- To examine how Technology teachers use Educational Technologies to design creative lessons and learning activities in the classroom.
- To analyse how Technology teachers use Educational Technologies to present creative lessons and activities that enhance learner engagement and understanding in classroom.

1.4.2 Research questions

RQ 1: What are the Technology teachers' understanding of various Educational Technologies used in presenting creative lessons before and after training?
RQ 2: What are teachers' perceptions of the impact of Educational Technologies and their understanding of Creative Teaching Skills?
RQ 3: How do Technology teachers use Educational Technologies to design creative activities and lessons?
RQ 4: How do teachers use Educational Technologies to present creative activities and lessons?

1.5 THEORETICAL FRAMEWORK

This study is grounded in Social Constructivism Theory, as developed by Lev Vygotsky (1978), which emphasises the importance of social interaction, discourse, and collaborative learning in the construction of knowledge. It was chosen on the bases for its ability to allow the exploration knowledge creation in a classroom context by guiding theoretical framework for the design and delivery of creative lessons in Technology Education. The framework was operationalised through three core categories: Interaction with Prior Knowledge (IPK), Interaction with New Knowledge (INK), and Construction of Own Knowledge (COK). These categories facilitated the

integration of Educational Technologies in ways that promoted learner engagement, critical thinking, and creativity. Through these dimensions, Social Constructivism provided a robust lens for exploring how Educational Technologies can enhance Creative Teaching Skills and deepen conceptual understanding in the senior phase Technology classroom. A detailed discussion of Theoretical framework is provided in Chapter Two of this thesis.

1.6 RESEARCH METHODOLOGY

This study to explore the development of Creative Teaching Skills among Technology teachers through the integration of Educational Technologies in senior phase classrooms. Anchored in a qualitative research approach, the study sought to explore complex educational phenomena within their natural context, allowing for a rich and nuanced understanding of teacher practices and pedagogical development. A qualitative action research design was employed to facilitate an iterative process of inquiry involving active participation, reflection, and collaboration between the researcher and the participants. This design was particularly appropriate for exploring how teachers develop and apply Creative Teaching Skills when supported by targeted interventions and the use of Educational Technologies. The study targeted Technology Education Honours students at a South African university. A combination of convenience and purposive sampling techniques was used to recruit participants who were both accessible and possessed specific expertise relevant to the study. The sample consisted of teachers enrolled in the Honours programme, all of whom specialised in Technology Education and were actively teaching. To address the research questions, multiple data collection methods were employed. These included pre- and post-class discussions, document analysis (of lesson plans and designed activities), non-participant classroom observations, and semi-structured interviews. The data analysis process relied on Qualitative Content Analysis (QCA) across all data sources. As this is a qualitative study, issues of trustworthiness are addressed by ensuring that credibility, transferability, dependability, and confirmability are thoroughly observed. A more comprehensive discussion of the methodology is presented in Chapter Three (3) of this thesis.

1.7 SIGNIFICANCE OF THE STUDY

This study holds significance in several respects. Firstly, its contribution to the body of research addressing existing gaps in literature, this study advances research on teacher professional development in Technology Education by exploring the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. Secondly, it offers valuable insights to the Department of Higher Education and Training (DHET) and the Department of Basic Education (DBE) into areas requiring attention within teacher training programmes on how to develop pre-service and in-service teachers' Creative Teaching Skills. Additionally, it presents a comprehensive framework for prioritising the integration of Educational Technologies to foster and enhance Creative Teaching Skills in classroom settings.

1.8 ETHICAL CONSIDERATIONS

According to King et al. (2018), the privacy of participants in research is a vital aspect that must be fully considered. Hence, ethical concerns are an integral part of the planning and the conducting of research. According to Wa-Mbaleka (2019), it is the responsibility of the researcher to ensure that ethical considerations are not compromised when designing and carrying out research.

1.8.1 Permission for the study

Before commencement of the research, the researcher obtained approval from the Higher Degrees Committee and ethical clearance from the Turfloop Research Ethics Committee. Thereafter, permission was obtained from the Office of the Registrar to conduct the study with Honours students enrolled in Technology Education during the 2023 academic year. Lastly, permission to conduct the study and access the circuit level of the selected schools was granted by the Limpopo Provincial Department of Education (see Annexures A, B, and C).

1.8.2 Informed consent

This refers to the procedure that requires the researcher to ensure that the participants in the research study are provided with important details about the study, including

risks and benefits, so that they may choose to partake in the study or not (Nnebue, 2010). Manti and Licari (2018) posit that informed consent and voluntary participation mean that participants have the right information regarding the research, for example, the impact it may have on their lives, the risks involved, and the benefits of participating in the study. In other words, the researcher ensured that the participants were fully aware of the research rationale, the methodology, and the intention behind the line of questioning. In addition, the participants were informed about their right to withdraw from the research at any time. Before commencing with the collection of data, the researcher sought consent from the teachers who were interviewed and observed. Furthermore, consent was sought from the parents or guardians of the learners of the selected schools where the observations were conducted, as the learners were considered participants during the lesson presentation by their teacher (See Annexure C and Annexure D).

1.8.3 Anonymity/Confidentiality

These terms refer to the treatment of all the information that an individual or a group has disclosed in confidence. The expectation is that it will not be made known to any third party without permission and in a manner that is at variance with the understanding of the original disclosure (Labrique et al., 2013). Therefore, for all the teachers interviewed and observed, no identifying information was collected. Similarly, the potential participants in the study were given adequate assurance that their information and identity would remain anonymous.

1.8.4 Voluntary participation

Participants in this study were made aware that their participation was based purely on their own volition without coercion (Babbie, 2020). The participants had the opportunity to complete a consent form, and they were made aware of their right to withdraw from the study with no compulsion to explain their withdrawal. This was done to ensure that participants understood their role within the context of the study and that they were fully aware of what the research entailed.

1.8.5 Respect for participants' dignity

In ensuring respect for the dignity and well-being of the participants, the researcher did not judge or discredit participants' views, inputs, or decisions. During the interactions with the participants, respect took precedence. Furthermore, the researcher ensured that the autonomy of the participants was protected, making certain that they did not feel vulnerable or marginalised. The researcher did not deceive the participants with lies or wrong information to lure them into participating in the study (Babbie, 2020).

1.8.6 Privacy

In ensuring that the privacy of the participants was respected throughout the research, the researcher refrained from asking the participants for personal and private information, as this might have led to the invasion of the participants' rights to privacy (Badiee et al., 2012). Moreover, the researcher safeguarded the privacy of the participants by ensuring that no participant was forced to take part in the study in a place or space where they might have been stigmatised. All interactions with the participants took place under conditions and during times that were suitable to them, which also ensured their privacy. In addition, the researcher did not conceal anything from the participants or deceive them when seeking information since this may have encroached on their privacy (Badiee et al., 2012).

1.8.7 Data storage and access

According to Liang et al. (2015), the security requirement of data storage is an important aspect because it is a way of guaranteeing the confidentiality of the data. This can be accomplished by employing existing cryptographic encryption mechanisms. Thus, for this study, a Public Key Encryption (PKE) was used. This allowed the researcher to encrypt the data that were stored in his computer and laptop under the public key. It also ensured that no one except a valid recipient could gain access to the data when sharing with the supervisor. The encryption of data only allowed specific individuals such as the researcher, supervisor, and an external examiner, if required, to gain access to the records. Using PKE meant that the confidentiality of the records/data could be effectively protected. Furthermore, hard

copies and all audio-visual recordings are to be kept safe at the University of Limpopo archives for up to five years.

1.8.8 Potential benefits to participants

The findings and recommendations of the study could provide the participants with a greater awareness of the areas for improvement regarding Technology Education as a subject, particularly regarding Creative Teaching Skills and the integration of Educational Technologies to enhance the teaching and learning of Technology. Therefore, the researcher explained the benefits of the study to the participants prior to them signing the consent form.

1.9 EXPLANATION OF KEY TERMS

Creative Teaching: is the teaching of content knowledge in a creative context that explicitly draw learners to engage imaginatively and that stretch their generative, evaluative and collaborative capacities to enhance meaningful learning in a classroom using of various approaches to present information (Cremin, 2022; Sawyer, 2019; Lucas & Spencer,2017).

Educational Technologies: are technological tools, resources, and systems such as computers, tablets, interactive whiteboards, educational software, online platforms, simulations, virtual reality, and even video tutorials that are used by teachers to support and enhance teaching and learning in the classroom (Haleem et al., 2022).

Technology Education: is a subject that stimulates learners' innovation and nurtures their creative and critical thinking skills. It equips them with the ability to manage time and material resources effectively, fosters collaborative learning and teamwork, and builds a strong foundation for further studies in Further Education and Training subjects and future career paths in the world of work (DBE, 2011).

Instructional strategy: is a structured plan or approach designed to guide teaching methods, learning activities, and assessment techniques to achieve specific learning objectives (Morrison et al., 2019).

1.10 OUTLINE AND ORGANISATION OF THE STUDY

This study consists of six chapters. Table 1.1 provides an outline of the organisation of the study.

Table 1.1: Outline and organisation of the study

Chapters	Heading of chapters	Description of chapters
1	General introduction to the study	Chapter 1 provides an overall view and is the foundation of the entire study. This chapter consists of the introduction, problem statement, purpose, and research questions of the study. It also provides a summary of the research methodology, the significance of the study, and the exposition of the study.
2	Literature review and theoretical framework	Chapter 2 provides a review of the literature that is relevant to this study. This includes discussions on local and global trends relating to the responsiveness to developing Technology teachers' Creative Teaching Skills through the integration of Educational Technologies. The chapter also presents the theoretical framework that was used in the study.
3	Research methodology and design	Chapter 3 presents the research design and the methodology that was used in this study. It provides the motivation for the choice of a qualitative research design and describes the population, sampling approach, research instruments, trustworthiness of the study, and ethical issues.
4	Presentation and discussion of the findings	Chapter 4 presents and discusses the findings. The data presentation is according to the research questions, using group interviews and interviews. Thereafter, the chapter presents a discussion of the findings according to the themes and categories that were taken from the theoretical framework that was used in this study.
5	Presentation and discussion of the findings	Chapter 5 presents and discusses the findings. The data presentation is according to the research questions, the document analysis, and the observations. Thereafter, the chapter presents a discussion of the findings according to the themes and categories that were taken from the theoretical framework and used in this study.
6	Conclusions, recommendations, limitations, and a proposed model	Chapter 6 provides the overall conclusions and the recommendations flowing from the study. The chapter also offers suggestions for further research. In addition, Chapter 6 presents and discusses, in detail, the proposed model (and its implications) that is aimed at closing the existing gaps in developing Technology teachers' Creative Teaching Skills through the integration of Educational Technologies.

1.11 SUMMARY OF THE CHAPTER

In this chapter, the trends regarding issues underlining Creative Teaching development, particularly of teachers, were highlighted. The problem statement was outlined together with the purpose of the study. The research questions, the significance of the study, and an outline of the study were also provided. The research methodology, the design, and the approach were briefly discussed in this chapter and followed by identification of the population and the sample group. Furthermore, a brief discussion of the study's data collection techniques was presented, followed by comments addressing the study's validity and reliability. The data analysis approach was highlighted in this chapter and followed by a brief account of the ethical requirements that were observed when the study was conducted. The chapter concluded with a brief overview of all the chapters in their respective sequence.

In the next chapter, a detailed review of the literature relating to this study is provided. Furthermore, the theory that underpins the study is fully discussed, laying the firm foundation upon which the study rests.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION OF THE CHAPTER

The previous chapter highlighted some of the developments and problems pertaining to Creative Teaching in Technology Education. Furthermore, the chapter outlined the purpose of the study, presented the research questions, provided a brief discussion of the significance of the study and the research methodology and design, and identified the population and study sample group. In addition, the chapter discussed the data-collection techniques that were used and gave a brief account of the quality criteria that guided the empirical work. It also provided highlights of the data analysis approach and the ethical requirements that were observed. The chapter concluded with an overview of all the chapters.

This chapter reviews the literature to highlight existing gaps in the body of knowledge relating to the topic under consideration. In a broader view, there is much evidence in the literature that Creative Teaching directly affects teaching and learners' learning. The chapter concludes with a description of the theoretical framework that guided this study.

2.2 INTEGRATION OF EDUCATIONAL TECHNOLOGY IN THE CLASSROOM

Technologies are influencing all aspects of life including education (Ratheeswari, 2018). Furthermore, they are promoting changes in working conditions, the handling and exchanging of information, teaching-learning approaches, and more (Amutha, 2020; Bindu, 2016). The significant advancements in contemporary technology have presented difficulties for all, especially teachers who must make sure that the technology in their classrooms is suitably incorporated into the curriculum (Nkosi & Mtshali, 2024). As such, technologies have much to offer to the world of creative sharing, for instance, new applications for content development/creation, the sharing of videos/audio/images across global contexts, and websites that allow diverse creators to share content (e.g., YouTube) (Nikolopoulou, 2018). Technologies change what people can do and enable them to do it better. The emergence of new technologies has made it possible to represent information and knowledge in many forms, including pictures, graphics, animations, and movies (Huang et al., 2019b).

Educational Technology refers to the use of tools, technologies, procedures, processes, resources, and approaches to enrich teaching and learning in a range of contexts (Huang et al., 2019b). Furthermore, the focus of Educational Technology is on pedagogical and technical approaches that assist with instruction and learning. Moreover, the use of Technology to support, facilitate, and improve instruction, learning, and performance falls under the broad category of educational Technology (Huang et al., 2019a). Technology-based teaching can provide learning that is more engaging, efficient, and successful than traditional classroom-based training since it has many affordances and capacities that enhance motivation (Wu et al., 2022).

In recent years, research has shown that Educational Technologies have become a motivational tool in evolving education throughout the globe (Bharati, 2023). The use of Educational Technologies involves a process of analysing, designing, producing, evaluating, implementing, and managing educational systems and other learning environments, leading to learning and the development of the mind, body, and spirit (Haleem et al., 2022). According to Morel and Spector (2022), the design, development, use, management, and assessment of learning processes and resources constitute the theory and practice of Educational Technology integration.

A study by Das (2019) on the role and impact of ICT in improving the quality of education showed that well-integrated Educational Technologies can greatly facilitate the acquisition and absorption of knowledge. Moreover, Educational Technologies can offer developing countries unprecedented opportunities to enhance educational systems, improve policy formulation and execution, and widen the range of opportunities for teaching and learning. The current study, therefore, recommends that Educational Technologies as tools can contribute to continuous educational innovation. They should thus be introduced into the schools' strategic plans, especially into each year's teaching plan. Moreover, when using Educational Technologies, teachers have a fundamental role in determining what to teach and how to teach it, and they must, therefore, be timeously trained for the development and use of these skills (Das, 2019).

The study by Ratheeswari (2018) on ICT in Education discovered that the integration of Educational Technologies improves the teaching and learning process. Hence, it is

important for teachers in performing their role as creators of pedagogical environments. Furthermore, it helps teachers to present their teaching attractively and enables learners to learn at any level of an educational programme. Therefore, Ratheeswari (2018) recommends that more attention be paid to the specific roles of Educational Technologies in offering multimedia simulations of good teaching practices, delivering individualised training courses, helping overcome teachers' isolation, continually connecting individual teachers to a larger teaching community, and promoting teacher-to-teacher collaboration. In addition, the intended outcomes, and the unintended results of using Educational Technologies for professional teacher development need to be explored.

Educational Technologies offer teachers and learners more opportunities in adapting learning and teaching to individual needs, and society is aptly forcing schools to respond to this technical innovation (Ratheeswari, 2018). Ugwu and Nnaekwe (2019) assert that Educational Technologies are making major differences in teaching approaches and the ways in which learners are learning. Educational Technologies enable teachers to make changes, try out alternatives, and monitor their ideas' development (Nikolopoulou, 2018). One of the key aspects of Educational Technologies is that content or knowledge can be created, shared, and discovered much more quickly and easily than previously (Henriksen et al., 2016).

2.3 UNDERSTANDING CREATIVE TEACHING IN CLASSROOM PRACTICE

Creative Teaching refers to a teaching method that promotes innovative, successful, and engaging teaching and learning while also advancing learners' confidence and competence in both creative and critical thinking (Ashton & Stone, 2021). Moreover, Barrett et al. (2021) and Sawyer (2011) maintain that the creative method of instruction is typified by creativity, improvisation, and collaboration. As such, Creative Teaching facilitates learners' acquisition of new material and helps them to apply it to real-world situations (Suyudi et al., 2022). Creative Teaching offers opportunities for learners to develop concepts, solve problems, think across disciplines, and foster collaborations (Lucas & Spencer, 2017). Moreover, Creative Teaching fosters critical thinking, confidence, and safety and is tolerant of mistakes (Lucas & Spencer, 2017).

Recent research has shown that Creative Teaching affects numerous facets such as performance, motivation and creativity, cognitive development, and the experiences of the learners (Tan et al., 2019). It is through Creative Teaching that the teacher is encouraged to change the teaching methods whenever necessary (Vigo Arrazola & Bozalongo, 2015). Furthermore, planning for Creative Teaching entails the teachers acting as both directors and actors. During their planning, teachers need to be the designers of lessons and the learning environment and at the time same, be the implementers of the designed lesson plan as the orchestrator and the facilitator (Tran et al., 2017). Therefore, teachers must continually develop more Creative Teaching methods to teach new generations of learners (Lin et al., 2016).

2.3.1 Creative Teaching with Educational Technologies

Creative Teaching involves teachers being creative and displaying clear and lively teaching methods to ensure that the learners are interested in their learning, thus enhancing the teaching effectiveness of teachers and in return, fostering creativity skills among the learners (Smith et al., 2018). Educational Technologies, with their new affordances, can stimulate and expand the way people think about creativity (Das, 2019). Henriksen et al. (2016) allude to the fact that the area of Creative Teaching is complicated and unbounded. Moreover, effective Educational Technology Integration into the classroom is intrinsically a challenging endeavour. Therefore, when Creative Teaching and of Educational Technologies Integration come together, as they must in 21st-century classrooms, the situation becomes more complex. As such, Integrating Educational Technologies for Creative Teaching in a classroom could be negatively affected by teachers' inadequate ICT knowledge and skills (Henriksen et al., 2021; Rana & Rana, 2020).

Similarly, Nikolopoulou (2018) laments that the process of infusing both Technology and creativity into the curriculum is a complex phenomenon. However, the curricula documents should consider the relevant issues and provide teachers with indicative activities for their lessons and examples of good practices (Nikolopoulou, 2018). Furthermore, the author argues that the best use of Educational Technologies in education requires a creative mentality that values being open to the unfamiliar and taking intellectual risks. Nevertheless, the majority of teachers would find this to be an

enormous undertaking, and as yet, it has not been thoroughly covered in the professional development of teachers, educational policy, or teacher education (Henriksen et al., 2016). Therefore, it may be difficult for teachers to integrate Educational Technologies so that learners can participate appropriately in class activities and debate, discuss, and draw conclusions (Antonietti et al., 2023).

In developed countries, the use of Educational Technologies in the education systems is significantly more advanced than the use of Educational Technologies in the education systems of developing nations (Kalolo, 2019). Furthermore, the use of Educational Technologies in developing nations is aimed at ensuring that teacher training equips teachers with new skills, thus introducing innovative pedagogies into the classrooms (Tondeur et al., 2016). Moreover, teachers are at the centre of the creative, collaborative, and interactive process. They oversee the organising and carrying out of the inclusive, creative work in the classroom that involves the integration of Educational Technologies (Dukuzumuremyi & Siklander, 2018; Rana, 2017). Consequently, a teacher's capacity to integrate Educational Technologies effectively depends on their knowledge, abilities, and proficiency with the technology; a teacher in the 21st century must be informed about a wide range of contemporary Educational Technologies (Willermark, 2021).

According to Bedir (2019) and Szymkowiak et al. (2021), teaching professionals may not always be aware of the educational opportunities that are associated with the near-universal availability of technologies in the digital age. “There is an agency for teacher education to focus on creativity, which would enable technology classrooms to flourish with creative ideas that are pragmatic to real-life scenarios” (Nkosi & Mtshali, 2024, p. 124). In the classroom, using Educational Technologies in a variety of subjects can foster unique, innovative, and cooperative learning experiences (Selfa-Sastre et al. 2022). Moreover, the integration of Educational Technologies contributes immensely to learners' achievement if the teachers can adequately orchestrate it in the classroom (Mayer, 2019). For example, Yuen et al. (2018) assert that the teaching and learning process can be fully enhanced by using technologies such as YouTube, animation, and simulation. Furthermore, Song and Kong (2017) declare that the use of Educational Technologies in teaching and learning is accompanied by several

advantages and benefits for both teachers and learners that would not be feasible without them.

2.3.2 Teachers' use of Educational Technologies to design and present creative lessons

Modern technologies frequently expose new creative opportunities for people. In the classroom, teachers need to be aware of the variety of inventive ways that Educational Technologies can share knowledge and how this interacts with various pedagogies (Henriksen et al., 2016). A creative teacher is expected to combine existing knowledge in a new or unique way or introduce a new process to nourish cognition and obtain a useful outcome (Khodabakhshzadeh et al., 2018). Furthermore, to attain their educational goals, learners need to be taught in a way that is clear, engaging, and supportive of their achievement, and this is known as teaching effectiveness. A teacher should prioritise both teaching and effective learning (Khodabakhshzadeh et al., 2018). Although most teachers use Educational Technologies to organise their lessons, the effectiveness of this use is not as high as one might expect from a class of 21st-century teachers (Huang et al., 2019a).

The success of learners and their attitudes towards learning are seen to be positively affected by teachers' use of Educational Technologies in lesson planning and delivery in the 21st century (Camacho et al., 2021). A study by Eyyam and Yaratan (2014) on the impact of Educational Technologies on mathematics revealed that the adoption of Educational Technologies by teachers had a positive influence on the overall performance of learners. Eyyam and Yaratan (2014) recommend investigating their use in subjects other than mathematics in further research. Murati and Ceka (2017) found the use of Educational Technologies in contemporary times to be important, particularly in education and teaching where learners take advantage of new knowledge. The use of Educational Technologies to deliver a lesson in a classroom can benefit both teachers and learners in numerous ways, including increased participation, interaction, knowledge diffusion, and comprehension (Nicolaou et al., 2019).

According to Bates (2019), a good quality lesson plan design is characterised by eloquent learning objectives, well-structured content, well-managed and controlled

workloads, integrated Technology, relevant learner activities, and assessment that is directly linked to the desired learning outcomes. Furthermore, the content to be taught, the resources that are available, the subject's nature, and other considerations all influence the choice of Educational Technologies for developing and delivering innovative lessons (Santos & Castro, 2021). Moreover, regardless of the approach that is employed by the teacher during the designing process, it is vital that as a designer, the teacher works towards designing conditions under which learners have a higher likelihood of learning (Parchoma et al., 2019).

According to Naik et al. (2021), Educational Technologies have the potential to assist teachers in creatively presenting lessons that seek to maximise the acquisition of knowledge in a fruitful and exciting manner. Likewise, integrating contemporary Educational Technologies enables teachers to be more creative in designing and presenting their lessons, thus making the learning more interesting. Moreover, teaching and learning can be more effective if the way that it is delivered matches the preferences of the current generation of learners known as ‘Gen Z’ (Hussin, 2018). However, Mynaříková and Novotný (2020) allude to the fact that although there is a repertoire of Educational Technologies available to teachers in this digital age, they are still not widely used in the classroom.

2.3.3 Teachers’ use of Educational Technologies to design creative activities

Designing and planning learning activities, deciding upon, and sequencing resources, creating items of instruction, and determining formative and summative assessments are conventional tasks undertaken as a plan is being designed (Huang et al., 2019b). Creative real-world approaches to teaching enable teachers to consider how Technology can assist them in viewing and teaching the content in creative or captivating ways. Furthermore, it allows teachers to create content rather than summarise and repeat it (Henriksen et al., 2016). Activity design in education is a specific human activity created by a teacher that is aimed at developing knowledge, skills, and the competencies of learners (Ghorbani et al., 2018).

A study conducted by Koh (2019) on Technological Pedagogical Content Knowledge design recommends the support of teacher pedagogical change. The study reveals that activity design should be meaningful, intentional, and useful. In designing learning

activities, meaningful aspects such as learning objectives, teaching, learning methods and interaction media, and operational procedures of tasks or activities should be fully considered by teachers (Jalinus et al., 2017). Similarly, Hussin (2018) emphasises that design activities should contain three crucial elements, namely learning tasks, learning methods, and evaluation requirements. Both learning design and instructional design are seen as stages in a process that teachers can use to plan, carry out, and assess their instruction (Carr-Chellman, 2016; Lee et al., 2017). The design of learning activities is a process that involves decision-making and problem-solving (Murtafiah et al., 2019).

The process of designing learning activities should be flexible and built upon a thorough examination of the learner, task, tool, and context. These form the basis of the learning activity, particularly its design, delivery, and evaluation of learning (Rapanta et al., 2020). A study by Goodyear and Dimitriadis (2013) on reframing the design for learning reveals that in designing activities, teachers need to consider the main components of a learning activity, components such as the context, the tools and the resources that are used, the concrete tasks, and the relationships between them.

2.3.4 Social Constructivism as an approach for teaching and learning

According to Anagün (2018), Constructivism is a popular approach when designing learning environments. The study of Anagün (2018) on teachers' perceptions regarding the relationship between 21st-century skills and managing constructivist learning environments indicates that it is the responsibility of teachers to design learning environments that develop creativity in the classroom. In agreement is the study of Sari et al. (2020) on the effects of STEM education on scientific process skills and STEM awareness in a simulation-based inquiry learning environment. The study alludes to the fact that learning environments should be designed in a way that allows opportunities for learners to develop 21st-century skills such as problem-solving, critical thinking, and creative thinking. Hence, the design of the learning environment is a vital aspect in supporting constructivist learning (Anagün, 2018). However, designing an effective learning environment has proved to be a difficult undertaking for teachers in helping learners to engage in and take responsibility for their own learning (Shyr & Chen, 2018).

Social Constructivism is a view of learning in which learners actively construct knowledge and learn based on their interaction with their environments (Suhendi, 2018). In the constructivist approach, learning is taking place not because of the transference of knowledge from teacher to learners via text or a personal knowledge base but because the learners interpret and make sense of their surroundings (Anagün et al., 2018). In this context, the teacher's role is to facilitate activities that will guide the learner into developing meaningful concepts (Anagün, 2018). Research has shown that learning environments should provide opportunities for experimentation with materials, information, and ideas (Fatahi, 2019). Moreover, the opportunities should cover risk-taking in a creative environment in addition to reflection and flexibility (Henriksen et al., 2021).

Furthermore, an educational technologically enhanced learning environment facilitates active, collaborative, creative, integrative, and evaluative learning, which is an advantage over the traditional method (Tunjera, 2019). In other words, Educational Technologies are becoming more appropriate in the realisation and implementation of the emerging constructivist pedagogy, which gives learners greater responsibility for their learning (Archambault et al., 2022; Sharma, 2015).

2.3.5 Teachers' views of the impact of Educational Technologies on preparing creative lessons and activities

Teachers use Educational Technologies for a variety of purposes – in supporting learner-centred teaching activities such as allowing learners to choose how to demonstrate their learning, in traditional or teacher-centred instructional practices such as lecturing or presenting, and in administrative/management tasks such as tracking learners' grades (Palak & Walls, 2009). The integration of Educational Technologies to enhance teaching and learning has gained recognition over the years due to Technology advancement (Huang et al., 2019a). However, the integration of Educational Technologies is largely determined by the teachers' knowledge and ability to use the Educational Technologies (Farjon et al., 2019).

A study conducted by Nazgul et al. (2020) on the opinions of pre-service teachers regarding the use of Educational Technologies in education uncovered those teachers

feel that there is limited use of Educational Technologies. However, the pre-service teachers acknowledge that the use of Educational Technologies increases efficiency and effectiveness when preparing materials for teaching. The study also found that computers and projectors were the commonly used Educational Technologies in the lessons. Furthermore, it was determined that positive attitudes towards using Technology such as smartboards were minimal and that was due to teachers limited exposure and limited technological skills (Nazgul et al., 2020). Similarly, a study by Moorhouse and Wong (2022) stated that to use Educational Technologies productively, teachers must understand how Educational Technologies can be used to present content and recognise that they can be synchronised with other teaching approaches.

2.3.6 Teachers' attitude on the integration of Educational Technologies

Attitudes are influential in the ways that people interact as participants of organisations and groups (Player-Koro, 2012). In education, therefore, the attitudes of teachers play a pivotal role in the integration of Educational Technologies in the teaching-learning process (Adegbenro et al., 2017; Lawrence & Tar, 2018). However, although the teachers' attitudes towards the use of these technologies are vital, previous research has revealed that teachers do not have clarity or the know-how on how far Educational Technologies can be beneficial for the facilitation and enhancement of the teaching and learning process (Harmandaoğlu Baz et al., 2018). Furthermore, teachers may have positive attitudes towards the Educational Technologies but still refrain from using them in teaching due to low self-efficacy and the tendency to deem themselves not qualified to teach with Technology (Inel Ekici, 2018).

The study by Sharma (2015) on the role of ICT in improving the excellence of education reveals that teachers' attitudes, motivation, computer anxiety, and computer self-efficacy are factors that affect teachers' use of computers in their lessons. Teacher resistance, technophobia, and lack of enthusiasm to use Educational Technologies in education may also be limitations. In addition, it may be that many teachers do not have the training that is needed to use the Educational Technologies in their teaching, or they may lack the required IT skills and as a result, feel uncomfortable (Spiteri & Chang Rundgren, 2020). Since teachers play a crucial and sensitive role in the

integration of Technology into the classroom, it is imperative that they acquire the fundamental skills and a willingness to experiment with the use of Educational Technologies in their classroom practices with care and consideration (Elmaadaway & Abouelenein, 2023; Farjon et al., 2019). Teachers' attitudes and views play a significant role in their decision to incorporate Educational Technologies consistently into their teaching methods (Adegbenro et al., 2017; Dinc, 2019; Lawrence & Tar, 2018).

2.3.7 The integration of Educational Technologies within the Social Constructivist Approach

According to Kimmons et al. (2020), the integration of Educational Technologies is about how to use technologies to support a way of teaching, while the transformation of technologies fundamentally changes the way of teaching and enables materials that could not be taught in the absence of Technology to be taught. The integration of Educational Technologies is the adoption and use of technologies in education content development, thus allowing learners to apply their Technology skills to learning and solving problems (Raihan & Han, 2012). Educational Technologies have been introduced into classroom practices because teachers believe that Technology has a considerable capacity to improve teaching and learning and offers a more active and stimulating learning approach (Tharayil et al., 2018).

The study of Raihan and Han (2012) that focuses on Educational Technology Integration for meaningful learning indicated that in a social constructivist context, teachers can scaffold and facilitate learning through the constituents of Educational Technology Integration. Raihan and Han (2012) opine that if constructivist pedagogical principles are joined with relevant Educational Technologies, major improvements vis-à-vis teaching and learning practices are likely. However, the teacher’s role is central to the effective integration of Educational Technologies in the classroom and many teachers may lack the knowledge that is necessary to improve teaching and learning in the classroom by incorporating Social Constructivism into their approaches to teaching (Barak, 2017).

Jha (2017) conducted a study on ICT pedagogy in higher education. The study showed that Educational Technologies have been an instrumental tool for knowledge

building in education. Additionally, Educational Technologies help learners with their construction of knowledge in their social setting. Similarly, a study by Asad et al. (2021) on the integration of e-learning technologies for interactive teaching and learning discovered that Educational Technologies can be used in constructing new knowledge in such a manner that the interaction between learners and teachers is enhanced in a more creative and meaningful way. Through the integrating Educational Technologies, learners can better understand content and contextualise it within their own environments, enhancing their ability to navigate daily lives (Jha, 2017; Koehler & Mishra, 2014). Moreover, for learners to construct their own knowledge, they need to be in contact with the available Educational Technologies that in tandem, seek to widen their horizons and update their knowledge (Adams Becker et al., 2017). Social constructivists reflect on Technology-adoption as a process of involving social groups in the innovation process in which learning takes place considering the learners' experiences, knowledge, habits, and preferences (Bondarouk, 2006; Kharade & Thakkar, 2017). Hence, Educational Technologies are a significant need in education, particularly in the context of building knowledge (Huang et al., 2019a).

2.3.8 Instructional strategies for Creative Teaching

An instructional strategy is a generalised plan for a lesson or a lesson that includes structure, an outline of the tactics that are necessary to implement the strategy, and the student's desire to learn in terms of the goals of instruction (Antoni, 2010)**.** Instructional strategy "is a concept, guideline, approach, or main line to conduct, measure and evaluate instruction'' (Seechaliao, 2017, p. 202). An instructional strategy is a description of an approach to a particular instructional or learning activity. Instructional strategies are closely linked with the type of material to be learnt (Aslan et., 2020).

The study by Seechaliao (2017) on instructional strategies to support creativity and innovation in education found that learners could create innovation creatively providing they followed the proper instructional strategies. Furthermore, Seechaliao (2017) demonstrated that Creative Teaching methods could influence learners' creativity. Certain instructional components need to be considered before an instructional strategy is implemented, for example, learners, learning objectives, contents, learning

context, overall context, conditions, and teachers' skills in selecting learning principles and the techniques to accomplish the learning objectives that they have specified (Seechaliao, 2017). Therefore, to make learners understand, it is imperative for teachers to understand the topics that they are teaching. Moreover, to conduct their instruction effectively and efficiently, teachers need to know the content that they will be teaching and the instructional strategies, as well as possess pedagogical content knowledge (Bayram-Jacobs et al., 2019).

The principles of designing instructional strategies are aligned with both teachers' Creative Teaching Skills and learners' learning styles. Furthermore, it is through good quality instruction that teachers facilitate learners' learning abilities, enrich learners' experiences, develop critical-thinking processes, and endeavour to create innovations in education to achieve their goals (Seechaliao, 2017). A study by Schacter et al. (2006) on how much Creative Teaching enhances learners' achievement found that many teachers did not implement any teaching strategies that fostered learner creativity. However, there were a few cases in which the teacher prompted the learners' creativity, but the teaching strategy was not aligned with the lesson objectives, or explained, or elaborated, and the purpose was not made clear to the learners (Schacter et al., 2006). Regarding the selection criteria, the results of studies have shown that when teachers decide to use Educational Technologies in teaching and learning, they must be guided by the lesson objectives, activities, subject policy, curriculum, learners' diverse learning needs, accessibility, and availability of the devices (Jatileni, & Jatileni, 2018).

2.4 CREATIVE TEACHING APPROACH THROUGH THE LENS OF SOCIAL CONSTRUCTIVISM

This study employed the Creative Teaching Approach as a lens to gain insights into the research problem (Shamsudin & Yusoff, 2014). According to Shamsudin and Yusoff (2014), a Creative Teaching Approach is characterised by teaching that is based on the thinking and learning style of the learners. The Creative Teaching Approach features six categories, namely physical resources, Technology and animation, diagram and colour, sound, writing and reading, and constructivism (Shamsudin & Yusoff, 2014). The Creative Teaching Approach is viewed as an

imaginative, dynamic, and innovative approach that inspires learners' imagination and new ideas and leads directly to teaching for creativity (Harris & De Bruin, 2018). In the Creative Teaching Approach, the inference is that a teacher may motivate learners to reflect on what creativity means and through their enhanced understanding, guide them to deploy their creative potential in certain ways and in particular situations (Henriksen, 2016; Jackson & Lassig, 2020). As indicated above, the Creative Teaching Approach is characterised by six categories (Shamsudin & Yusoff, 2014). However, in this study, the development of teachers' Creative Teaching Skills only focused on Educational Technologies (Technology and animation) and constructivism (constructivist) categories. Other categories were excluded because this study did not focus on developing teachers' Creative Teaching Skills through writing, reading, and physical resources.

The study chose Educational Technologies since they would provide the tools to develop Creativity Teaching Skills while the Social Constructivism category would provide the methodological approach to teaching. Figure 2.1 below shows how the two categories were explored in this study.

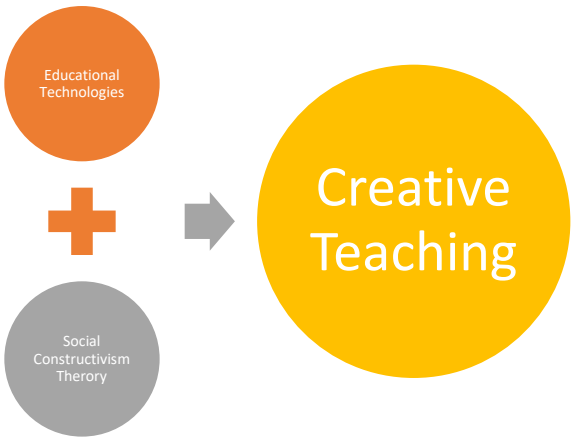


Figure 2.1: The classification of categories for Creative Teaching

According to Shamsudin and Yusoff (2014), Technology and animation is a Creative Teaching technique that encompasses Educational Technologies such as the internet and smartboard. In this study, Educational Technologies encompassed the use of tools such as animation, YouTube videos, and other Educational Technologies to develop teachers' Creative Teaching Skills. Moreover, Creative Teaching is expected to encourage learners to adopt and use active techniques to acquire more knowledge

and then reflect on what they are doing and how it improves their understanding (Shamsudin & Yusoff, 2014). Therefore, for this study, the Social Constructivism Theory served as a guideline for teachers to design lessons and activities that are constructive and creative using Educational Technologies.

The theoretical framework is the most critical component of any research process. The theoretical framework has several functions, including providing the structure and backing for the study's justification and acting as the cornerstone upon which all knowledge is built (Collins & Stockton, 2018). A strong theoretical framework makes it easier for the reader to understand the researcher's point of view and proves that the suggested study is supported by reliable empirical data (Grant & Osanloo, 2014). Hence, this study employed Social Constructivism Theory as a framework that offers an all-encompassing perspective for exploring the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. Therefore, Social Constructivism Theory as a framework was used to direct the designing and presentation of lessons for Creative Teaching in a classroom.

According to Vygotsky (1978), discourse, information sharing, and belief comparison are essential for facilitating learning and helping others to build an awareness of normative social ideals. The Social Constructivism Approach views social interaction as the fundamental component in knowledge construction, placing it above individual discovery. Ideas are tested, developed, and changed via social interaction and sharing rather than through an internalised, solipsistic process of judgement (Mohammed & Kinyó, 2020). Furthermore, Social Constructivism relates to the learner's interpersonal interaction in the classroom combined with their individual critical thinking process (Barak, 2017; Kalina & Powell, 2009).

This study was situated within the principles of the Social Constructivism Theory of Vygotsky (1978). According to Vygotsky (1978), the Social Constructivism Theory is a theory of knowledge that asserts that human development is context-specific and socially situated, and knowledge is constructed in the process of interaction with other individuals. Amineh and Asl (2015) emphasise that Social Constructivism is a theory of knowledge in sociology and communication that looks at the understandings and

knowledge that people form collectively about the world. As such, learners should not only work with their teacher one-on-one, but they should also work with other learners since learners have much to offer one another (Kalina & Powell, 2009). In addition, Social Constructivism emphasises that each person absorbs knowledge at a different rate based on their personal experiences when they master completing tasks or activities in a group (Kalina & Powell, 2009; Mohammed & Kinyó, 2020). Furthermore, the theory assumes that understanding, significance, and meaning are developed in co-ordination with other human beings (Amineh & Asl, 2015).

According to Phillips (1995), Social Constructivism can be achieved through a variety of learner roles, including social, creative, and active learners. Phillips (1995) went on to say that since learning is a social construction, the only way to interpret what is known is through social interaction. Moreover, Social Constructivism holds the notion that knowledge may be produced and recreated, necessitating learners' active participation in order to learn new knowledge (Pritchard & Woollard, 2010). Social Constructivism places a strong emphasis on ‘collective learning’, which recognises the value of community members, parents, teachers, and peers in assisting learners and fostering successful learning (Jha, 2017; Pan et al., 2017). Additionally, Kamath and Kumar (2023) assert that the hallmark of Social Constructivism is collective learning / group learning, which is contextual, interactive, and social and in which parents, teachers, peers, and other community members play significant roles.

Social Constructivism in teaching emphasises reciprocal teaching, peer collaboration, cognitive apprenticeships, problem-based instruction, web quests, anchored instruction, and other methods that involve learning with others (Kakeeto, 2021). In Social Constructivism, instructors are introduced as facilitators rather than teachers (Amineh & Asl, 2015). This significant change in the instructor’s role indicates that an instructor as a facilitator needs to display a completely different set of skills than that of an instructor as a teacher (Crosby, 2000; Amineh & Asl, 2015). Hence, the facilitator assists learners in developing their own comprehension of the material while the teacher delivers a didactic lecture covering the subject matter (Adom et al., 2016; Amineh & Asl, 2015). A facilitator poses a question by offering support; a facilitator offers direction and establishes the right conditions so that learners can arrive at their

own findings; a facilitator converses with the learners continually and interactively (Amineh & Asl, 2015; Devi, 2019).

Social Constructivism, which assumes that cognitive growth first occurs on a social level and later on an individual level, emphasises the role of zone of proximal development (Vygotsky, 1978). Similarly, Amineh and Asl (2015) contend that Social Constructivism is an approach that holds the view that learning is active, allows learners to construct their own knowledge, and is determined by learners' previous knowledge. Moreover, under Social Constructivism, learners take independent action first, and thereafter, with guidance from the teacher, they use what they have learnt to solve new problems (Margolis, 2020). Relatedly, Raihan and Han (2012) explain Social Constructivism as an interaction with new knowledge where knowledge and skills are better understood. They further indicate that meaningful and deeper learning is derived from proper links across relevant prior knowledge and new knowledge and the construction of knowledge (Raihan & Han, 2012).

Hence, the Social Constructivism Approach in this study was viewed through Interaction with Prior Knowledge, Interaction with New knowledge and Construction of Own Knowledge. Furthermore, these categories provided guidelines on how teachers design lessons and activities that encourage meaningful learning. In addition, the approach was used to design the research instruments to collect the data. Table 2.1 below explains how the Social Constructivism Approach was understood while designing and presenting lessons and activities using various Educational Technologies.

Table 2.1 Social Constructivism Approach

Interaction with Prior Knowledge (IPK)	Interaction with New Knowledge (INK)	Construction of Own Knowledge (COK)
Stage 1: Lesson design Teacher identifying relevant technologies that • Allow learners to interact with prior knowledge in a real-life context. • Allow learners to interact with prior knowledge in a previous lesson. • Allow learners to interact with prior knowledge from a previous grade.	**Stage 1: Lesson design** Teacher identifying relevant technologies that • Allow learners to interact with new knowledge in a real-life context. • Allow learners to exchange, debate and negotiate ideas actively within their groups in a way that increases learners' interest in learning. • Allow learners to apply themselves as they try to get clarification and understand the concepts.	**Stage 1: Lesson design: activity** Teacher identifying relevant technologies that • Allow learners to display what they already know and further build on new knowledge through design activities. • Provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt these in arriving at their own interpretations of a phenomenon. • Allow learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge.
Stage 2: Lesson presentation Teacher using various technologies to • Deliver a lesson that will enable learners to ask relevant questions, explore, and assess what they know. • Deliver a lesson that will entertain learners' knowledge from past experiences and influence the processing of the new or altered knowledge that they will create from new learning experiences. • Deliver a lesson that will enable the teacher to know the learners' pre-existing conceptions, to guide the activity to address them and thereafter, to expand upon them.	**Stage 2: Lesson presentation** Teacher using various technologies to • Deliver a lesson that will enable learners to apply current understandings, note relevant elements in new learning experiences, judge the consistency of prior and emerging knowledge, and based on that judgement, modify knowledge. • Deliver a lesson that will enable learners to engage effectively as they become more informative about certain concepts in a subject area. • Deliver a lesson that will push learners to generate new information using active methods (experiments, real-world problem-solving) and then to discuss and reflect on their work and how their understanding is evolving.	**Stage 2: Lesson presentation** Teacher using relevant technological tools to • Deliver a lesson that will expose learners to real-life situations where they are empowered to execute, monitor, and regulate the process of knowledge construction. • Deliver a lesson that will enable learners to construct their own knowledge actively through experiences and interactions with others. • Deliver a lesson to support effective instruction that is engaging, interdisciplinary, learner-centred, and deeply related to real-life phenomena and individual learning styles and needs.

2.5 SUMMARY OF THE CHAPTER

This chapter discussed the literature in relation to Creative Teaching through the integration of Educational Technologies. In this chapter, gaps were identified within the literatures of studies that have been conducted on the topic of interest. The literature reviewing process allowed the researcher to uncover areas that have not been fully researched or need further researching. Furthermore, Chapter 2 provided the Social Constructivism Theory that underpinned the study. Chapter 3 outlines the research methodology, which consists of the research approach and design, population and sampling, data collection and analysis, and ethical considerations, all of which are in support of the purpose of the study.

CHAPTER 3: RESEARCH METHOLODOLOGY AND DESIGN

3.1 INTRODUCTION OF THE CHAPTER

The previous chapter addressed the literature review and the theoretical framework that was employed in this study. The chapter identified existing gaps regarding the development of Creative Teaching Skills through the integration of Educational Technologies into the teaching and learning process. This included discussions on Creative Teaching with Educational Technologies, teachers' use of Educational Technologies to design and present creative lessons, teachers' use of Educational Technologies to design creative activities, the Social Constructivism Approach for the learning environment and Creative Teaching; teachers' views on the impact of Educational Technologies in preparing creative lessons and activities, teachers' attitudes on the integration of Educational Technologies, and instructional strategies for Creative Teaching.

This chapter describes the research methodology of the study. The chapter starts with the preferred paradigmatic approach and the research approach and design, which were considered the optimal medium for achieving the overall purpose of the study. The discussion of the research approach and design is followed by a description of the population and sampling, indicating the techniques used to select participants within the broader context of the study. The instruments used to collect the data are discussed thereafter and followed by the data analysis process. The overall data quality including its trustworthiness and how the ethical requirements were observed and adhered to are also considered. Below is a summary table of the study's methodology, encompassing the research approach, design, and data collection strategies.

Table 3.1: Research approach, research design, and data collection methods

Research approach	Research design			
Qualitative exploratory design	**Action research study**			
	Phases of enquiry			
Data collection methods and instruments	Pre and post group interviews ▪ Semi-structured, face-to-face group interviews ▪ Interview protocol	Document analysis ▪ Designed lesson plans ▪ Designed activities ▪ Checklist	Non-participatory observation ▪ Non-participatory classroom observation ▪ Observation schedule ▪ Audio recorder	Semi-structured interviews ▪ Semi-structured interviews ▪ Interview protocol
Analysis of data	Qualitative content Analysis	Qualitative content analysis	Qualitative content analysis	Qualitative content analysis

3.2 PARADIGMATIC APPROACH

According to Kivunja and Kuyini (2017), a paradigm is a philosophical mode of thought. Guba and Lincoln (1994) cited by Ugwu et al. (2021) view a paradigm as a fundamental framework or worldview that serves as the researcher's guide. Therefore, for this study, the interpretivist paradigm, which is concerned with how the social world is viewed and comprehended, was used (Kivunja & Kuyini, 2017). Its relevance was informed by the purpose of the study, which was to acquire deep insights from the lived realities of particular people within a certain setting (Gray, 2021), in this case, a teacher at a particular school presenting a creative lesson using Educational Technologies in a classroom. The interpretivist paradigm allowed the researcher to investigate the development of the teacher through a series of steps undertaken for the development of Creative Teaching Skills in a more practical setting (O'Donoghue, 2018).

3.2.1 Ontology

Ontology refers to the researcher's presumptions about reality, which influence the subject matter of the study and how it is seen and conducted (Ugwu et al., 2021). In

this study, ontology is defined as the belief that something is real or makes sense or as the fundamental characteristics of the social phenomenon under investigation (Kivunja & Kuyini, 2017). This was appropriate for the study, as it focused on exploring how Technology teachers develop Creative Teaching Skills through the integration of Educational Technologies, and how their experiences influence their classroom practices. Additionally, it was significant to this research as it enabled the researcher to gain a deeper understanding of the complex realities of teaching and learning. This was achieved through multiple data collection methods, including pre- and post-group interviews, document analysis, observations, and semi-structured interviews (Wilson, 2020). As a result, ontology is fundamentally a step in the creation of the lifeworld (Garrido, 2022).

3.2.2 Epistemology

Epistemology refers to the description of how we know what we know by including knowledge and embodying a particular view of what it is to know (Kivunja & Kuyini, 2017). Consequently, epistemology in this study was used by the researcher to establish how to go about revealing knowledge and skills on the integration of Educational Technologies for Creative Teaching in the social context that was explored (Al-Ababneh, 2020; Kivunja & Kuyini, 2017). The relevance of the epistemology in this study was that it enabled the researcher to focus on how people judge what is true; it also examined how scholars relate to reality and the path they take to arrive at the truth (Dew & Foreman, 2020). Research conducted in the epistemological dimension is thought to be an attempt to discover the truth or reliable information (Gorichanaz, 2017). In this study, the researcher employed pre- and post-group interviews, document analysis, observations, and semi-structured interviews to explore the lived experiences of Technology teachers. Furthermore, the epistemology was informed by the assumption that what people experience, they experience in different terms.

3.3 RESEARCH APPROACH

This study used a qualitative research approach to explore the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. Qualitative research is a research

technique used by researchers to study social practices and human behaviour (Stake, 2010). A qualitative research method is used by researchers investigating human behaviour and experiences to gather in-depth insights into a problem, and this involves gathering and analysing non-numerical data (Creswell, 2013). The qualitative research method was considered suitable since the researcher had no control over the variables. This allowed the unrestricted and natural emergence of the themes that the researcher identified during the study (Hammarberg et al., 2016).

3.4 RESEARCH DESIGN

In this study, Technical Action Research (TAR) was employed. Technical Action Research is an iterative cycle of planning, doing, observing, and reflecting in a collaborative manner as a critical participatory action to confront the inconvenient consequences of social practices (Coghlan, 2019). Furthermore, it promotes the development of novel knowledge to enhance instructional strategies and problem-solving techniques and facilitates the understanding and the improvement of processes of change in education (Ronen, 2020). Technical Action Research served as a pivotal design in this study, significantly contributing to the teachers' professional development. Specifically, TAR allowed the researcher to identify the problem, design a targeted intervention, and collaborate with participating teachers to ensure effective implementation (Mertler, 2024). According to Kemmis et al. (2014), TAR is linked to research about practical knowledge and demonstrates educational improvement; it entails analysis and change both on the side of the individual and on the side of the culture of the group. This enabled the researcher to assist the teachers in improving their educational practice through methods that involved action, evaluation, and reflection (Clark et al., 2020). Additionally, the researcher gathered data to effect change in teachers' practices (Coghlan, 2019). In this study through TAR as part of the intervention, to bring about a solution a two-cycle process was undertaken. This research design is relevant since it allowed the researcher to develop teachers' Creative Teaching Skills.

This study adapted the action research profile by Brooks (2010). It consists of sequential segments in each stage that are as follows:

- Planning a change through action
- Action-Actual session with the participant

- Post-Observation of the session action
- Reflection on the action
- Refining (e.g., of the created system setup or the strategies to address the natural systems)
- Planning the next action and repeating the stages for the other cycles

Figure 3.1 below present the stages of action research developed by Brooks (2010).

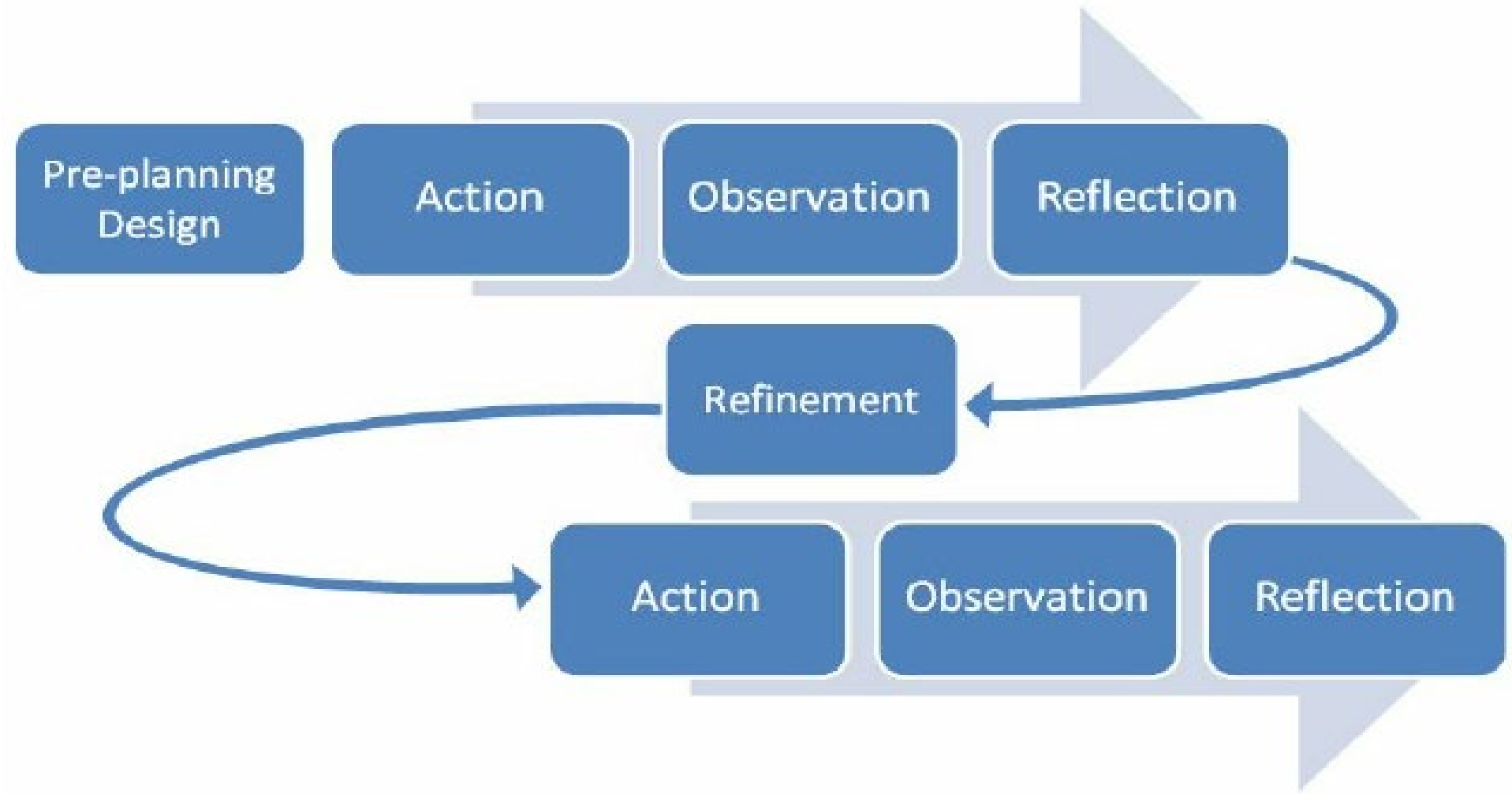


Figure 3.1: Two iterations of the action research process

Source: Brooks (2010)

--

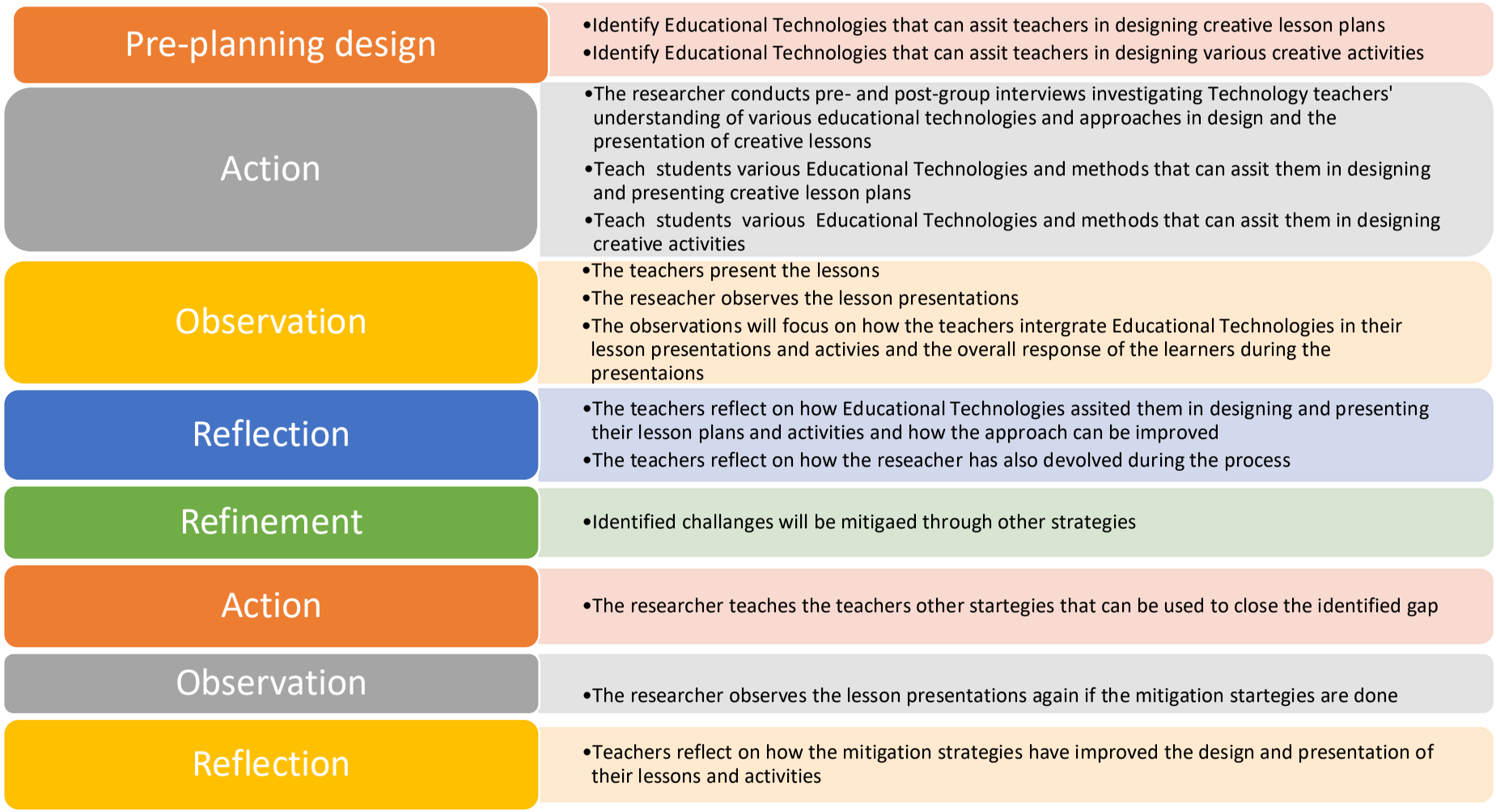


Figure 3.2: Explanation of the stages

In view of the above, Figure 3.2 above also provides an explanation for each of the stages in the context of the study in Technology Education since the study of Brooks (2010) was action research conducted in healthcare. The stages are adapted in line with the Social Constructivism Approach presented in Table 2.1. Each cycle containing four stages. First cycle stages pre planning design, action observation and action. Second cycle stages refinement, action, observation, and reflection.

3.5 STUDY SETTING

The setting for the study was as follows: The Limpopo Province Department of Basic Education's jurisdiction spans over ten (10) educational districts, which are geographically distributed as follows: Capricorn North, Capricorn South, Sekhukhune East, Sekhukhune South, Vhembe East, Vhembe West, Waterberg, Mogalakwena, and Mopani East, Mopani West. The participants of this study were enrolled for honours in Technology Education and practicing as teachers in some of the Districts in the Limpopo Province South Africa. For this study, data were collected from participants working as teachers in the following districts: Capricorn North, Capricorn South, Sekhukhune East, and Sekhukhune South.

3.6 POPULATION AND SAMPLING

The population of this study comprise of thirteen (13) postgraduate students enrolled for Bachelor of Education (B.Ed.) Honours in Technology Education. This is the total number of possible participants that this study could engage with, and that population is understood as the targeted participants who could possibly take part in the study (Etikan et al., 2016). Hence, the targeted participants were those doing B.Ed. honours in Technology Education with some teaching experience in the field.

This study employed a combined convenience and purposive sampling approach to recruit thirteen (13) in-service teachers enrolled in a B.Ed. Honours program in Technology Education at a South African university. The convenience aspect stemmed from participants' geographical proximity to the researcher, ensuring accessibility, while the purposive selection targeted specifically Technology Education Honours students willing to participate in the study (Etikan et al., 2016). This dual

sampling strategy was appropriate for the study's aims, as it enabled the targeted selection of participants most relevant to the research objectives. Of the thirteen participants, seven (7) who were also actively practicing as senior phase Technology teachers in different schools around Limpopo province. The selected seven teachers were required to design and submit creative lesson plans and learning activities, which were analysed by the researcher. Additionally, their implementation of these lessons was observed, and in-depth, face-to-face interviews were conducted to gain deeper insights into their experiences and practices. This approach aligns with Etikan et al.'s (2016) assertion that purposive sampling is effective when the goal is to identify individuals with specialised knowledge or experience related to the phenomenon under investigation. were further selected using a stratified sampling approach for additional data collection methods.

3.7 DATA COLLECTION

During data collection, much-needed information was retrieved through a thorough and precise search focusing on relevant issues. This was conducted to avoid ignorance and excessive work (Rutten, 2015). For the purposes of the action research design, an array of data collection instruments was used to gather data, namely group interviews (pre and post interviews), document analysis (designed lesson plans and designed activities), non-participatory observation, and semi-structured interviews. Each of these data collection methods was used to address each of the research questions. The table below summarises the data collection approaches and instruments used in this study

Table 3.2: Data gathering techniques and instruments

Participants	Data collection method	Research question	Data collection instrument	Documentation
Honours Students/Teachers	Pre & post group interview	RQ1, RQ3	Interview protocol	Transcript
	Document analysis	RQ2, RQ3	Checklists	Document Analysis Matrix
	Lesson observation	RQ4	Observation schedule	Field notes and audio recordings
	Semi-structured interview	RQ2	Interview protocol	Transcript

3.7.1 Pre and post the semi-structured group interview

To understand Technology teachers' knowledge about various Educational Technologies and approaches in the design and presentation of creative lessons, the study employed the semi-structured group interview. A group interview is a data collection method that adopts a semi-structured group session steered by the researcher in an informal setting with the sole aim of collecting data on any given topic (Carey, 1994). Pre the intervention, the focus of the semi-structured group interview was on the teachers' knowledge of various Educational Technologies and approaches used in designing and presenting creative lessons before training (see Annexure F). Conversely, post the intervention, the focus of the semi-structured group interview was on the teachers' knowledge of various Educational Technologies and approaches used in designing and presenting creative lessons after training (see Annexure G). The study used a group interview since it allowed the researcher to extract information about the teachers' level of understanding of the issues under question (McLafferty, 2004). The interview schedule was designed to focus on two elements, teachers' knowledge about various Educational Technologies and teachers' knowledge about various approaches in the design and presentation of creative lessons, which included the categories of IPK, INK, and COK.

3.7.2 Document analysis

To understand Technology teachers', use of Educational Technologies to design creative lessons and activities, the study used document analysis. This technique assisted the researcher to respond to RQ3 and RQ4. Document analysis is the analysis of both printed and electronic materials that may be used to draw out meaning, achieve deeper understanding, and cultivate empirical knowledge (Corbin & Strauss, 2008). In this study, the document referred to the lesson plans and activities that were designed by the teachers and later presented in a classroom. These documents were either printed or in an electronic format. The table below outline the types of documents analysed and their descriptions.

Table 3.3: Document analysis

NO.	ITEM	DESCRIPTION
1	Lesson plan	Teacher-designed lesson structure to guide the teacher during the lesson presentation in the classroom
2	Activity	Teacher-designed activity for learners to complete at the end of the lesson presentation

3.7.2.1 Lesson design

To understand how teachers use Educational Technologies to design their lessons, the study scrutinised the teachers' lesson plans. In teaching, a lesson plan is a preparation that is developed based on the teacher's thoughts pertaining to what is appropriate for the learners and what the curriculum or the syllabus expects the teacher to do (Rodriquez et al., 2017). To collect data on the designed lesson, the researcher developed a checklist tool to understand how teachers use Educational Technologies to design their lessons. A checklist analysis tool was relevant in this study because it assisted the researcher in performing certain quality checks on critical components of a lesson plan that are germane to teaching and learning (Krom & van den Hoven, 2022). As indicated in Table 2.1, the researcher used the Social Constructivism Approach to design the checklist. The checklist investigated the teachers' use of various Educational Technologies and the Social Constructivism Approach, which included learners' IPK, INK, and COK (see Annexure H, Section A).

3.7.2.2 Activity design

To explore how teachers use Educational Technologies to design creative activities, the study scrutinised the activities that were designed by the teachers, taking into consideration a learning approach that fosters learners' innovation, creativity, adaptation, and fun (Alejandro & David, 2018). To extract data from the designed activities, the researcher used the developed checklist tool to understand the teachers' use of various Educational Technologies and approaches in designing creative activities. The checklist as an analysis tool is relevant in this study because it assisted the researcher in performing quality checks on vital parts of the activity design that are appropriate for teaching and learning (Krom & van den Hoven, 2022). As indicated in Table 2.1, the researcher used the Social Constructivism Approach to design the checklist. The checklist looked at the teachers' use of various Educational

Technologies and the Social Constructivism Approach, which included learners' IPK, INK, and COK (see Annexure H, Section B).

3.7.3 Non-participant observation

To explore how Technology teachers use Educational Technologies to present creative lessons, the study employed the non-participatory observation technique. Non-participatory observation is an investigation in which the participants are aware of the observations taking place but in which they are not involved (Lavia et al., 2018). This technique assisted the researcher in responding to RQ4. through gathering data through observation, the researcher, as a non-participant observer, was able to extract more information in a more pragmatic setting (Ciesielska et al.,2018). This technique is relevant because it allowed the researcher to understand phenomena in nature, their relationships, and their interactions in a new way without prevalent categorisations and evaluations (Ciesielska et al., 2018). To extract data during the observations, the researcher used the developed observation schedule to understand how the teachers use Educational Technologies to present creative lessons in their classroom. An observation schedule can be used to categorise different segments of observed behaviour in a particular setting. The relevance of the observation schedule rests upon the allowance it gives the researcher to generate data through taking notes of everything that occurs in the classroom space (Phellas et al., 2011). In addition to the observation schedule, to extract more data during the observations of the current study, the researcher used an audio recorder from the beginning of the session to the end to capture moments of interactions during the presentation and understand the level at which learners may have acquired knowledge. This is relevant because it allowed the researcher to adopt the narrative approach. The narrative is a form of writing that tells the story of what exactly transpired during the lesson presentation. As indicated in Table 2.1, the researcher used the Social Constructivism Approach to design the observation schedule. The observation schedule looked at teachers' use of various Educational Technologies and the Social Constructivism Approach, which included learners' IPK, INK, and COK (see Annexure I).

3.7.4 Semi-structured interviews

In a bid to grasp the teachers' perceptions of the influence of technologies on the development of Creative Teaching Skills and the extent to which Technology teachers understand the Creative Teaching Approach, the study used the semi-structured interview technique. Semi-structured interviews are a qualitative approach to collecting data; they commence with a set of standardised questions that are presented to multiple respondents and lead to an ongoing discussion and the posing of appropriate follow-ups questions that elaborate on more general knowledge (Ahlin, 2019). This assisted the researcher in responding to RQ2. The researcher conducted face-to-face interviews with the participants (Creswell & Creswell, 2017). This technique was relevant because it afforded the researcher an opportunity to gather information from the research participants using a set of semi-structured questions (Roulston & Choi, 2018). This allowed the researcher to delve deeper into the topic areas generated by the participants, helping the researcher to understand how and why somethings are done and providing data to support the more rigorous and expected outcomes relating to the question that had been posed (Ahlin, 2019). As indicated in Table 2.1, the researcher used the Social Constructivism Approach to design the set of semi-structured questions. The questions were concerned with teachers' perceptions of the impact of Educational Technologies on developing their Creative Teaching Skills**.** The interview schedule looked at the impact of Educational Technologies on developing their skills to design creative lessons and activities and present creative lessons that encourage learners' IPK, INK, and COK in the classroom (see Annexure J).

3.8 DATA ANALYSIS

Analysing qualitative data is a systematic and organised process through which qualitative data are categorised into manageable units; combined and synthesised into ideas; and developed into constructs, subjects, patterns, or theories that accentuate the important findings of the research (Suter, 2012; Saldaña, 2021). In this study, for analysing all the data that were collected from the document analysis (lesson plans and activities, data collected pre and post the interviews, participatory observation, and semi-structured interviews), Qualitative Content Analysis (QCA) technique was employed. Qualitative Content Analysis is defined as an empirical, methodologically

controlled approach to the examination of texts in their communicative context according to content analytical norms and step-by-step models while avoiding hasty quantification (Mayring, 2019).

3.8.1 Analysis of data pre and post the semi-structured group interviews

Qualitative Content Analysis of the data collected pre and post the semi-structured group interviews was carried out. Qualitative Content Analysis is referred to as recorded communications that may be records of interviews, discourses, observation protocol, documents, and video tapes (Mayring, 2014). This was used because it allowed the researcher to become familiar with the gathered data. Furthermore, a clear understanding of the gathered data was formed through the examination of the transcribed interviews and the field notes that were taken during the interviews. Through QCA, the data were encoded, specifically looking for certain words according to which themes and subthemes could be identified (Cho & Lee, 2014). As indicated in section **3.7.1**, the schedules for the pre and post semi-structured group interviews were developed according to the Social Constructivism Approach. Furthermore, they were used as categories for the presentation and analysis of the data.

3.8.2 Analysis of lesson plans

The document analysis of the lesson plans was conducted using QCA. In this study, the recorded documents were the lesson plans that were designed by the Technology teachers. As indicated in section **3.7.2.1**, the data were collected using the checklist that was developed according to the Social Constructivism Approach. Additionally, constructs of Social Constructivism were further used as categories for the presentation and analysis of the data. The extraction of the data from the lessons that were designed by the teachers was guided by the components adapted by Astarina (2020) from Brown (2001) and Reiser and Dick (1996). The components were topic, objective, activities, Educational Technologies, and assessment. The table below outlines the key components of a creative lesson plan.

Table 3.4: Components of a creative lesson plan

NO.	COMPONENTS	INDICATORS
1.	Topic	Clearly outlined
2.	Objectives	Linking with the topic
		Being measurable
		Revealing specific skill
		Revealing specific areas of learning
		Including terminal lesson / empowering objectives
3.	Exercises	Having a topic
		Matching with the objectives
		Presenting new information and examples
		Providing practice and feedback
		Transitioning from receptive to productive
4.	Technologies/Media	Brings practicality
		Being effective when used
5.	Assessment/Activity	Corresponding with the activities
		Determining the objectives

3.8.3 Analysis of activity design

The document analysis of the designed activities was conducted through QCA. In this study, the recorded documents were the designed activities that were developed by the Technology teachers. As indicated in section **3.7.2.2** the checklist used to collect the data was developed according to the Social Constructivism Approach and was further employed as categories for the presentation and analysis of the data. The extraction of the data from the teachers' designed activities was guided by the components identified by De Hei et al. (2016). These were interaction, learning objectives and outcomes, assessment, task characteristics, structuring, guidance, group constellation, and facilities. The table below outlines the key components of a Components of a creative activity.

Table 3.5: Components of a creative activity

No.	Components	Description
1.	Interaction	This means that the teacher needs to decide how the interaction regarding this learning objective should take place. Perhaps learners must give each other feedback or debate and discuss.
2.	Learning Objectives and Outcomes	The learning objective of a learning activity is described as the ability of learners to help each other to develop skills.
3.	Assessment	This should focus on grading the quality of the learning, the acquisition of knowledge, and skills development.
4.	Task Characteristics	Providing each other with feedback to assist in the development of the presentation of skills should be one of the activities described in the task characteristics. The task, therefore, should be to give an oral presentation (conditional on providing feedback on the presentation of skills) and provide feedback on the presentations of peers.
5.	Structuring	The collaboration and interaction between learners to accomplish the desired learning objective can be performed by the teacher by determining in what manner (e.g., a given format) and how often learners should provide feedback. Another consideration as part of structuring could be whether the teacher prescribes the manner of providing feedback or whether the learners are allowed to determine themselves how they organise the feedback sessions.
6.	Guidance	The extent and the manner of guidance that the teacher foresees as necessary is what should be decided next. This guidance should be focused on coaching learners on how to solve a problem or arrive at a solution
7.	Group Constellation	What group size and composition are the most suitable for this task? The teacher could decide, for instance, that groups of four learners consisting of two more- and two less-skilled learners are suitable.
8.	Facilities	The facilities for helping each other may be instructions for and formats of providing feedback and a digital environment that enables learners to watch the presentations of their peers' numerous times and to download all information and upload their feedback.

3.8.4 Analysis of non-participatory observations

The analysis of the non-participatory observations was conducted through a QCA of the observed phenomena. This approach was used because it allowed the researcher to identify the research topic, create content categories, and test the established categories. The focus of the analysis was informed by RQ4. Therefore, the data collected during the observations through audio recordings were analysed using the narrative approach. The narrative approach took a storytelling format and provided details of all that transpired from the beginning of the lesson to the end. Adopting the narrative approach was relevant because it enabled the researcher to understand and analyse the audio recordings from this perspective rather than, for example, focusing merely on the content of the observation schedule (Earthy & Cronin, 2008). Furthermore, the narrative was not only concerned with the storytelling or narrative components of the account but also with the distinctive social interactions that occurred during the lesson presentation, and which fostered and influenced the manner in which the account was presented (Earthy & Cronin, 2008). In addition, the recorded field notes were scrutinised, and the observation schedules for all the observed lessons were harmonised, thus allowing the researcher to reflect and perhaps recast certain issues. The researcher focused on how the in-service teachers used Educational Technologies in their classroom practice, thereby capturing confidence, skills, types of tools, relevance, and appropriateness of use, content, and verbal communication. The audio recordings were listened to repeatedly to identify and examine the content to make new meaning from the activities that were engaged in during the teaching and learning process. As indicated in section **3.7.3**, the observation schedule used to collect data was developed according to the Social Constructivism Approach. Furthermore, it was employed as categories for the presentation and analysis of the data.

3.8.5 Analysis of semi-structured interviews

Qualitative Content Analysis was adopted for the purpose of analysing the data that were gathered from the interviews because it allowed the researcher to become familiar with the data. Furthermore, a clear understanding of the data that were gathered was formed through the examination of the transcribed interviews and the written notes that were taken while conducting the interviews. Through the QCA, the

data were encoded, specifically looking for certain words according to which themes and subthemes could be identified (Cho & Lee, 2014). As indicated in section **3.7.4**, the interview schedule used to collect the data was developed according to the Social Constructivism Approach. Furthermore, it was employed as categories for the presentation and analysis of the data.

3.8.6 Presentation and discussion of the data

In this study, the presentation and discussion of the data is offered in Chapter 4 and Chapter 5, respectively. The presentation and discussion of the data is in accordance with the research questions. The decision to split the presentation and the discussion of the data was informed by the size of the data that were collected in response to the four research questions. Therefore, for readability, cohesion, and logic, the researcher grouped RQ1 and RQ2, and being informed by direct links between the two questions, they were presented and discussed in Chapter 4. Similarly, RQ3 and RQ4 were grouped, and being informed by direct links between the two questions, they were presented and discussed in Chapter 5. Moreover, as pointed out in Chapter 2 under section **2.4**, the study used the Social Constructivism Approach (Vygotsky, 1978) as a framework to present the study's findings. The framework has three categories, namely IPK, INK, and COK. The table below delineates the core categories of Social Constructivism Theory underpinning this study.

Table 3.6: Social Constructivism Theory categories for this study

No.	Category	Explanation
1	**Interaction with Prior Knowledge**	In this study, the focus of this category was on how Creative Teaching, through the effective integration of Educational Technologies in the planning and presentation of lessons, helps the learner to comprehend the Interaction with Prior Knowledge in a Technology classroom.
2	**Interaction with New Knowledge**	In this study, the focus of this category was on how Creative Teaching, through the effective integration of Educational Technologies in the planning and presentation of lessons, helps the learner to comprehend the Interaction with New Knowledge in a Technology classroom.
3	**Construction of Own Knowledge**	In this study, the focus of this category was on how Creative Teaching, through the effective integration of Educational Technologies in the planning and presentation of lessons, helps the learner to comprehend the Construction of Own Knowledge in a Technology classroom.

The Technology teachers' design and presentation of lessons that enhanced the comprehension of the categories of Social Constructivism in teaching and learning using Educational Technologies enabled the researcher to arrive at conclusions regarding the applicability of the different themes under the Creative Teaching Approach.

3.9 QUALITY CRITERIA

Qualitative studies are not numeric, so they often do not adopt the use of standardised instruments (Merriam & Grenier, 2019). Qualitative research is suitable for studies involving smaller and/or non-random samples (Merriam & Grenier, 2019). Qualitative research is assessed not with scientific measures such as reliability and validity but rather, through trustworthiness. Therefore, in conducting qualitative research, it is crucial to ensure that issues pertaining to the trustworthiness of a study are not taken for granted or compromised. Trustworthiness criteria are perceived to evaluate qualitative research. Furthermore, trustworthiness is achieved by ensuring that the following criteria are adhered to: credibility, transferability, dependability, and confirmability (Creswell & Creswell, 2017; Lincoln & Guba, 1985).

3.9.1 Credibility

Credibility refers to the extent to which a given study represents the objective realities or actual meanings of the participants in the research (Lincoln & Guba 2005). To enhance the credibility in this study, an individual with expert knowledge in research was consulted. This individual examined the findings of the study, the meanings deduced from the qualitative data, and the interpretation and conclusions reached from the participants' opinions.

3.9.2 Transferability

Transferability refers to the criticality of research-policy nexus, that is, the degree to which the findings of a research are applicable to policy and decision-making based on the research data, conclusions, and recommendations (Moon et al., 2016). To enhance transferability in this study, the research method was detailed and, therefore, the findings

present the objective proof that may be applied to policy and/or decision-making.

3.9.3 Dependability

Dependability refers to a quality measure that focuses on ensuring that the findings of a study are further tested to increase the confidence in the evidence (Adams et al., 2014). The process of auditing research is important because it makes research traceable. It also ensures that the research is thoroughly documented in a reflexive manner by giving a detailed account of the research process and the methods adopted in the collection of data and the description of the research findings.

3.9.4 Confirmability

Confirmability refers to a criterion that is deployed to measure the credibility of a qualitative study. When the meaning derived from a study is underlain by reliability and relevance, the study is said to possess the quality of confirmability (Streubert Speziale et al., 2003). This is the extent to which the findings of a given research are acceptable to other researchers or scholars who work in the same or related fields. Therefore, for this study, the confirmability criterion was adopted. This process involved the provision of the step-by-step, methodological and self-critical account of how the research was carried out. Furthermore, the data that were collected during the study are being kept securely, but the researcher will ensure the availability of the data in the event that the findings are challenged by others.

3.10 ETHICAL CONSIDERATIONS

According to King et al. (2018), the privacy of participants in research is a vital aspect that must be fully considered. Hence, ethical concerns are an integral part of the planning and the conducting of research. According to Wa-Mbaleka (2019), it is the responsibility of the researcher to ensure ethical considerations are not compromised when designing and carrying out research.

3.10.1 Permission for the study

Prior to commencing the study, the researcher sought and obtained approval from the Higher Degrees Committee and ethical clearance from the Turfloop Research Ethics Committee (see Annexure A). In addition, permission was granted by Provincial Department of Education to gain entry in different circuits and conduct the study in the selected public schools (see Annexure B). Furthermore, gatekeeper permission was secured from the University Registrar (see Annexure C).

3.10.2 Informed consent

This refers to a procedure that requires a researcher to ensure that the participants in the research are provided with important details about the study, including the risks and benefits, so that they may choose whether to partake in the study or not (Nnebue, 2010). Manti and Licari (2018) posit that informed consent and voluntary participation mean that participants have the right information regarding the research, the impact it may have on their lives, the risks involved, and the benefits of participating in the study. Therefore, consent was sought from the teachers who were to be interviewed and observed and from the parents and/or the guardians of the learners of the selected schools where the observations were made (see Annexure D and Annexure E).

3.10.3 Anonymity/Confidentiality

These refer to the treatment of all the information that an individual or a group has disclosed in confidence with the expectation that it will not be made known to any third party without permission or in a manner that is at variance with the understanding of the original disclosure (Labrique et al., 2013). Therefore, no identifying information was collected from the teachers who were interviewed and observed. Similarly, the participants in the study were given adequate assurance that their information and identity would remain anonymous.

3.10.4 Voluntary participation

Participants in this study were made aware that their participation was based purely on their own volition without coercion (Babbie, 2020). The participants had the opportunity to complete a consent form and they were made aware of their right to withdraw from the study with no compulsion to explain their withdrawal.

3.10.5 Privacy

The researcher desisted from seeking personal and private information, as this might have breached the participants' right to privacy (Badiee et al., 2012). Moreover, the researcher safeguarded the participants' right to privacy by ensuring that no participant was forced to take part in the study in a place or space where they might have been pilloried. All contact with the participants took place in locations, under conditions, and at times that suited the participant, thereby protecting their privacy. In addition, the researcher did not conceal anything from the participants or deceive them when seeking information since this may have encroached on their privacy (Badiee et al., 2012).

3.10.6 Access and storage

According to Liang et al. (2015), the security requirement of data storage is an important aspect in a study; it is a way of guaranteeing the confidentiality of the data. Using existing cryptographic encryption mechanisms can be employed to fulfil this requirement and ensure that no one except the valid recipient can gain access to the data. For this study, PKE was used, allowing the researcher to encrypt the data under the public key for data stored in a computer and laptop or when sharing the data with the supervisor. The encryption of data only allows specific individuals to gain access to the records such as the researcher, the supervisor, and the external examiner, if required. By using PKE, the confidentiality of the records/data was protected effectively. Hard copies and all audio-visual recordings are to be kept safely at the University of Limpopo archives for up to five years.

3.10.7 Potential benefits to participants

The findings and recommendations of the study would provide the participants with a greater awareness on areas for improvement regarding Technology education as a subject, particularly in relation to Creative Teaching Skills and the integration of Educational Technologies to enhance the teaching and learning of Technology. Therefore, the researcher explained the benefits of the study to the participants prior to signing the consent form.

3.10.8 Respect for participants' dignity

In ensuring respect for the dignity and well-being of the participants, the researcher did not judge or discredited participants' views, inputs, and decisions. During the interactions with the participants, respect took precedence. Furthermore, the researcher ensured that the autonomy of the participants was protected by making certain that they did not feel vulnerable or marginalised. The researcher did not deceive the participants with lies or wrong information to lure them into participating in the study (Babbie, 2020).

3.11 SUMMARY OF THE CHAPTER

This chapter addressed the following aspects: the research approach, the research design, the population and sampling, data collection, and the data analysis process. Furthermore, the quality criteria and the encounters and strengths of the current study were ascertained. Finally, the chapter outlined the ethical considerations to which the researcher adhered during the research process. The next chapter presents the data findings and the discussions relating to these.

CHAPTER 4: PRESENTATION AND DISCUSSION OF FINDINGS FOR RESEARCH QUESTION 1 AND 2

4.1 INTRODUCTION OF THE CHAPTER

The previous chapter focused on the research methodology that was used in this study. It covered the paradigmatic approach, the population and sampling strategy, the research approach, the research design, and a thorough explanation of the data gathering tools and the data analysis process. The chapter also rigorously upheld ethical research standards and ensured the reliability of the research tools.

Chapter 4 presents the discussion of the findings form the data that was collected with various instruments and informed by the research questions outlined in Chapter 1. In this study, a set of four research questions informed the process of obtaining and presenting the data. Each research question was linked to a research data collection tool. However, for this chapter, the presentation of the data and the discussion of the findings focus mainly on RQ1 and RQ2. The reason to group RQ1 and RQ2 was to ensure cohesion and logic in the presentation of the data. Firstly, to respond to RQ1, data were collected pre and post the group interviews. Secondly, to respond to RQ2, data were collected through semi-structured interviews.

This chapter starts by profiling the teachers who participated in the study. Profiling is important, as it helps to understand the knowledge and experience of the participants in relation to the area of interest. This is followed by the presentation of the data in relation to RQ1 and RQ2.

4.2 TEACHERS' PROFILES

In this study, seven teachers from five different circuits/districts in the Limpopo province were observed and interviewed. Their profiles are provided on Table 4.1 below.

Table 4.1: Participants' profiles

Name (Pseudonym)	Age category	Gender	Qualifications	Major subjects	Teaching experience	Urban/rural school	ICT skills
Lebrone	20-24	Male	B. Ed Degree	Mathematics & Technology	1 year	Rural	Advanced
Jude	20-24	Male	B. Ed Degree	Mathematics & Technology	1 year	Rural	Advanced
Judith	20-24	Female	B. Ed Degree	Mathematics & Technology	1 year	Rural	Good
Calton	20-24	Male	B. Ed Degree	Mathematics & Technology	1 year	Rural	Good
Jolie	25-30	Female	B. Ed Degree	Mathematics & Technology	3 years	Rural	Good
Kevin	25-30	Male	B. Ed Degree	Mathematics & Technology	2 years	Rural	Advanced
Kim	25-30	Female	B. Ed Degree	Mathematics & Technology	3 years	Rural	Good

The interpretation of each teacher should be understood in the following way. Jolie is a female teacher between the ages of 25-30. She holds a B Ed degree in which she specialised with Mathematics and Technology. She has taught Technology subject for about 3 years in a rural school. Her ICT schools are fairly good, making her the ideal candidate to participate in this study. Nevertheless, Table 4.1 reveal that all participants are recently qualified teachers with teaching experience ranging from 1 to 3 years. Their ICT skills range from good to advanced, suggesting competence and openness to using Educational Technologies. However, limited rural infrastructure may hinder effective implementation. These factors are key to understanding how their context and backgrounds influence the research findings.

4.3 WHAT ARE THE TECHNOLOGY TEACHERS' KNOWLEDGE AND UNDERSTANDING OF VARIOUS EDUCATIONAL TECHNOLOGIES AND APPROACHES USED IN DESIGNING AND PRESENTING CREATIVE LESSONS BEFORE AND AFTER TRAINING?

This question was responded to twice, in the group interviews before the intervention and in the group interviews after the intervention.

4.3.1 Group interviews pre intervention

These interviews were to determine the teachers' knowledge and understanding of Educational Technology Integration prior to the researchers' intervention programme. The honours class comprised 13 students with 7 students already practising as teachers. During the interview, the class was divided into two groups, one group with six members and the other group with seven members. The aim was to have smaller and more manageable groups enhance data quality by encouraging participation, fostering deeper and more focused discussions, and creating a comfortable environment. Additionally, to make participants feel more confident to express themselves fully (Flynn et al., 2018). Below are the questions asked and the responses from the teachers' grouping.

Question 1: Do you use any Educational Technologies when designing a creative lesson and activity?

Group 1

Responses

Teacher 1: Yes, I often use my laptop

Teacher 4: Yes, sometimes

Teacher 6: No, I normally use ready-prepared lesson plans from textbooks companies

Group 2

Responses

Teacher 7: Yes, I use a laptop

Teacher 9: Yes, uses computer but not always

Teacher 11: Yes, but not always

In view of the above, the use of Educational Technologies by teachers during the designing of lessons is a common practice. Most of the teachers who were teaching at the time of data collection used Educational Technologies. However, a few of them indicated that they did not used them often. This coincides with the findings of Huang et al. (2019a) that most teachers use Educational Technologies to plan their lessons, but their use is not as effective as one might anticipate from a class of teachers in the 21st century.

Question 2: Which Educational Technologies do you normally use when designing creative lessons and activities?

Group 1

Responses

Teacher 1: Laptop

Teacher 3: Laptop and printer

Teacher 5: Laptop

Teacher 4: Tablet

Teacher 6: PowerPoint slides

Group 2

Responses

Teacher 7: Laptop/computer

Teacher 8: Laptop and projector

Teacher 10: Laptop

Teacher 11: Tablet

Teacher 13: YouTube videos

Most teachers responded that they often use laptops or tablets when designing creative lessons. This is not surprising since laptops and tablets as Technology tools were available as a learning resource through their academic journey as undergraduate students. However, a few teachers mentioned that in addition to laptops/tablets, for effective integration, they included PowerPoint slides and YouTube videos to aid in the comprehension of the content being taught. Resonating with the views of Bedir (2019) and Szymkowiak et al. (2021) that living in the digital age in which technologies are available to almost everyone does not necessarily mean that teachers are aware of the opportunities that such technologies can bring in education. For instance, Yuen et al. (2018) state that technologies such YouTube, animation, and simulation can be used to enhance the teaching and learning process.

Question 3: What factors do you consider when choosing Educational Technologies during the design of creative lessons and activities?

Group 1

Responses

Teacher 1: Familiarity with the educational Technology tool(s)

Teacher 2: Availability of the educational Technology tool(s)

Teacher 3: Likeness of educational Technology tool(s)

Teacher 4: Content to be taught

Group 2

Responses

Teacher 8: Know how best to use the educational Technology tool(s)

Teacher 9: Availability of the educational Technology tool(s) in the school

Teacher 11: The nature of the subject – practical/theory

Teacher 13: Content to be taught

The consensus was that the selection of Educational Technologies in designing creative lessons is influenced by various factors. The teachers provided multiple responses, highlighting the notion that teachers have different perspectives regarding the use of Educational Technologies in designing lessons. They, therefore, have different reasons informing their choice of Educational Technologies for designing. Two teachers mentioned the factors of likeness and familiarity with Educational Technologies; however, these were not relevant to the course. Two teachers indicated the factors of content to be taught and availability of the Educational Technologies, and these were relevant to the course. These findings relate to the views expressed by Santos and Castro (2021) that the selection process of Educational Technologies for designing and presenting creative lessons is guided by various factors such as content to be taught, availability of resources, and nature of the subject.

Question 4: Do the Educational Technologies used during lesson or activity presentation promote the Interaction of Prior Knowledge (IPK)?

Group1

Responses

Teacher 3: Yes, it allows the teacher to make a presentation of pictures to be on a 3D.

Teacher 5: Yes, learners can see and respond based on what they saw.

Teacher 6: Yes, if it is well used, it helps learners to understand better.

Group 2

Responses

Teacher 7: Yes, it captures the learner's interest.

Teacher 8: Yes, it keeps learners engaged.

Teacher 9: Yes, it makes [it] easy to facilitate the lesson.

Teacher 12: Yes, it ensures that learners are always preoccupied.

All the teachers agreed on the positive aspect of Educational Technologies of how they can be used to allow the learners to engage with prior knowledge, although none of the

teachers provided a clear account of how IPK is promoted. However, the consensus was that the use of Educational Technologies for lesson presentation brings about positivity for both learners and teachers. This resonates with the views expressed by Haleem et al. (2022) and Nicolaou et al. (2019) that the use of Educational Technologies to present a lesson in a classroom can be beneficial for both teachers and learners in several ways such as enhancing engagement, interaction, and dissemination and comprehension of knowledge.

Question 5: Do the Educational Technologies used during lesson or activity presentation promote the Interaction of New Knowledge (INK)?

Group1

Responses

Teacher 1: Yes, learners ask question[s] based on what they see on the whiteboard.

Teacher 2: Yes, it provides a clear presentation of information.

Teacher 3: Yes, the learners can watch a YouTube video repeatedly up until they understand.

Teacher 4: Yes, after watching a video, [they] can respond to questions asked by the teacher.

Group 2

Responses

Teacher 7: Yes, learners see and learn what is being taught.

Teacher 9: Yes, a teacher is able to present better for learners to understand what is taught.

Teacher 10: Yes, the learners can watch a video repeatedly for a better understanding of a concepts taught.

Teacher 12: Yes, after presentation of PowerPoint slides or a video, [the learner] can respond to questions asked by the teacher.

All the teachers agreed that the use of Educational Technologies promotes INK. The narrative drives the notion that the use of Educational Technologies enables better

presentations and flexibility to disseminate information for better acquisition and comprehension of knowledge. This complements the view of Naik et al. (2021) that Educational Technologies have the potential to assist teachers in presenting creative lessons that seek to maximise the acquisition of knowledge in a fruitful and exciting manner.

Question 6: Do the Educational Technologies used during lesson or activity presentation promote the Construction of Own Knowledge (COK)?

Group1

Responses

Teachers 1: Yes, as a teacher, I can perform simulation and let learners respond to questions in a form of an activity.

Teachers 3: Yes, the use of Educational Technologies can provide better visualisation for the learners.

Teacher 5: Yes, after watching a YouTube video, [they] can do a class activity on their own.

Teacher 6: Yes, the use of educational Technology can, in [a] way, unlock the creativity of the learners.

Group 2

Responses

Teacher 7: Yes, the lesson learners can complete a project on their own.

Teacher 8: Yes, learners can do a mini-PAT [practical assessment task] on their own.

Teacher 12: Yes, learners can write a test and pass.

All the teachers agree that the use of Educational Technologies can promote COK if they are well integrated. However, none of the teachers provided a clear explanation of how the integration of Educational Technologies promotes COK. Hence, the narrative driven by the teachers' responses is that the teachers seem not to understand how well the integration of technologies can be effectively used to enhance COK in a classroom. This aligns with the view of Antonietti et al. (2023) that teachers experience challenges in

integrating the Educational Technologies that enable learners to engage, debate, discuss, and make inferences properly when completing an activity in a classroom. According to Rana and Rana (2020), teachers may lack the knowledge and skills on how to integrate Educational Technologies effectively in classroom activities to promote discussions, interactions, collaborations, etc.

Question 7: Which Creative Teaching strategies (to engender IPK, INK, and COK) do you adopt that facilitate the integration of Educational Technologies during the presentation of lessons and activities?

Group1

Responses

Teacher 2: I sometimes use posters with information in relation to the content to be taught.

Teacher 3: I print pictures from the internet and make a collage that I will use for to support my lesson presentation.

Teacher 6: Yes, I sometimes used PowerPoint presentation to share pictures with a better view for learners to have a better understanding.

Group 2

Responses

Teacher 7: I prepare presentation slides of my lesson using the PowerPoint.

Teacher 9: I print pictures from the internet (e.g., when teaching gears, I will print pictures of gears in 3D for better visualisation).

Teacher 12: No, I do not because the school where I am working, there are not resources [and] no electricity in the classes.

The responses of the teachers in this instance show that teachers do try to be creative in their teaching for the enhancement of knowledge and skills. However, the strategies that they are using may be below par and a misfit to the Generation Z class of learners. This is because none of the teachers considered the integration of Educational Technologies for Creative Teaching, and given the current age of Technology advancement, the expectation would be that teachers fully exploit the affordances of Educational

Technologies. This is line with Henriksen et al. (2021) that teachers' limited knowledge and skills of ICT may be detrimental to the integration of Educational Technologies for Creative Teaching in a classroom.

4.3.2 Group interviews post intervention

The post-intervention discussion sought to determine the teachers' knowledge and understanding of the integration of Educational Technologies into the teaching and learning process after the researcher's intervention. Below are the questions that were asked and the teachers' responses.

Question 1: Did the lessons presented on the integration of Educational Technologies for Creative Teaching help you with the know-how in identifying relevant Technology that you can use during lesson planning / lesson presentation?

Group1

Responses

Teacher 1: Yes, before I could just use laptop to design slides for lesson due [to] familiarity and exposure to PowerPoint.

Teacher 3: Yes, I got expose[d] to a collection of Educational Technologies such as YouTube videos, simulations, animations, and etc. that can be used to creatively present a lesson for better comprehension of knowledge.

Teacher 4: Yes, I have learnt about different kinds of Educational Technologies that I can use for lesson designing and presentation to provide flexibility and creativity.

Group 2

Responses

Teacher 8: Yes, it did. I know that there is [a] range of Educational Technologies to integrate for creative lessons presentation.

Teacher 11: Yes, I have learnt that content can be presented in various ways for better understanding (e.g., using PowerPoint presentation with YouTube videos interchangeable or simultaneously).

Teacher 13: Yes, I have learnt how to effectively integrate Educational Technologies, taking into account certain aspects to make it effective.

Most of the teachers agreed that the intervention by the researcher was informative and a revelation in various aspects. The teachers are now able to employ various types of technologies for the design and presentation of creative lessons. Hence, the point driven by the narrative here is that it is critical for teachers to be skilled and knowledgeable about the vast range of Educational Technologies for better decision-making regarding their effective integration. This concurs with the findings of Willermark (2021) that in the 21st century, a teacher needs to be knowledgeable about a variety of contemporary Educational Technologies because their potential and their effective integration rests upon the teacher's knowledge, ability, and skills relating to these technologies.

Question 2: Have you learnt anything in regard to the identification and use of Educational Technologies?

Responses

Group1

Responses

Teacher 2: Yes, I have learnt that for an effective or successful integration of technologies should be informed by a number of aspects (e.g., content and learners' learning styles).

Teacher 4: Yes, the selection of Educational Technologies should not be a random process, but it needs to be guided by a set of principles.

Teacher 5: Yes, selection should not be informed by likeness nor familiarity but aspects such as content to be taught, objectives, etc.

Group 2

Responses

Teacher 7: Yes, I have learnt that selection of Educational Technologies is [a] process that needs systematic planning by the teacher in order to ensure effective integration of technologies.

Teacher 9: Yes, I have learnt that the selection of Educational Technologies to be used in lesson presentation is not an isolated process but influences by a number of factors (e.g., content, objectives, diversity, and etc.).

Teacher 10: Yes, I have learnt that selection of Educational Technologies is an educated process that requires a certain knowledge and understanding of Educational Technologies that will enable a teacher to take informed decision during the process.

Teacher 12: Yes, the more often you use it, you become more fluent and efficient with [the] whole process.

The teachers' responses show that through the intervention programme, they learnt that the selection of Educational Technologies, either for lesson designing or lesson presentation, should be guided by a set of principles and informed by aspects such as content to be taught, learning objectives, and learners' learning styles. One of the teachers added that the use of technologies often sharpens one's digital skills. Therefore, the narrative is that the knowledge acquired by the teachers helped them in relation to the selection of Educational Technologies, which was informed by various aspects and guided by a set of principles. This is in accordance with the articulations of El-Sabagh (2021) and Shahid et al. (2019) that the process of choosing Educational Technologies for effective integration must consider a variety of factors, including age, environment, diversity, learning styles, learning objectives, and content.

Question 3: Is the use of Educational Technologies in Creative Teaching of importance/value to the teaching and learning process?

Responses

Group1

Responses

Teacher 3: Yes, it enables one to present content or material in multiple formats for better comprehension and understanding.

Teacher 4: Yes, it is through the integration of Educational Technologies [that] a teacher can make a lesson presentation using YouTube videos/simulation, helping

learners to better visualise a concept that is being taught for better comprehension of knowledge.

*Teacher 6: Yes, if the use of Educational Technologies is appropriately planned and executed, it brings with it numerous advantages that enhances [*sic*] the delivering and acquiring of knowledge [and] creativity on both teachers and learners with much needed flexibility.*

Group 2

Responses

Teacher 8: Yes, it [is] due to the flexibility that it provides. The use of Educational Technologies enables a teacher to carry out demonstration[s], simulations to help learners to make links to what is taught and what they already [know] about certain concepts.

Teacher 10: Yes, it is through the integration of Educational Technologies [that] a teacher can creatively present a lesson in [a] way it could not be possible without the Technology.

Teacher 12: Yes, if technologies are well incorporated, they can maximise positive outcomes in a classroom.

Most of the teachers agreed that the use of Educational Technologies provides flexibility for lesson presentation. In addition, the use of Educational Technologies enabled them to present a lesson creatively and in a way that they could not do in the absence of Technology. The teachers saw the value and importance of using Educational Technologies for Creative Teaching. The notion here is that if Educational Technologies are purposefully integrated into teaching and learning, they have much to offer in relation to the acquisition and comprehension of knowledge and in enhancing the achievement of the desired outcomes. This resonates with the findings of Haleem et al. (2022) that technologies offer new ways to propagate information and knowledge, to facilitate communication, and to present motivational learning tools. In addition, Song and Kong (2017) allude to the integration of Educational Technologies into teaching and learning as bringing about many positives and benefits for both teachers and learners that would be impossible in the absence of technologies.

Question 4: Are there any factors that influence the identification of an educational Technology tool for the design and presentation of a creative lesson?

Group1

Responses

> *Teacher 1: Yes, the learning objectives – not only for the identification of Educational Technologies but also the instructional strategies to be used*
>
> *Teacher 2: Yes, the content to be taught is very crucial in selection of Educational Technologies.*
>
> *Teacher 3: Yes, there are a number of factors to be taken into consideration when making a selection of Educational Technologies to be used such as the content, context, and learners' learning styles.*
>
> *Teacher 4: Yes, learning objectives and what is [to] be taught are amongst factors to be considered during this process guided by principles.*

Group 2

Responses

> *Teacher 10: Yes, the identification or selection of Educational Technologies is not a solo process but a [*sic*] teachers have to take to account a number of factors to ensure its effectiveness during teaching and learning (e.g., content, learning objectives, teaching strategies, and etc.).*
>
> *Teacher 11: Yes, the content to be taught. Environment is important to consider during the selection process of Educational Technologies and sometimes, the knowledge of the learners about a certain Technology tool if [it is] to be used by learners during the teaching and learning process.*
>
> *Teacher 12: Yes, the selection or identification of Educational Technologies has to be informed by factors such as the content, context, objectives, and learners' learning styles.*

In this instance, the consensus among most of the in-service teachers was that the selection of Educational Technologies is influenced by various factors such as content, objectives, and the learners' learning styles. Moreover, one teacher mentioned that even the instructional strategies could be used to facilitate the lesson. The point driven by the

narrative here is that content and learning objectives are the main drivers of the whole selection process. As articulated by Kale et al. (2020), for effective integration of Educational Technologies that enhance teaching and learning, teachers need to be cognisant of various factors such as the content to be taught and achievable learning objectives.

4.3.3 Summary

Before the intervention programme, it was revealed that the teachers lacked the knowledge and skills relating to the integration of Educational Technologies. Therefore, incorporation of Educational Technologies was seldom carried out during their presentations in the classroom. However, influenced by their exposure and past experiences, when they did decide to integrate Educational Technologies, they opted for a laptop/tablet and a projector to display PowerPoint slides. Furthermore, their selection process was unorthodox, compromising the effectiveness of the integration. The teachers valued what the technologies bring to teaching and learning in the classroom, but they could not provide a detailed account of how they are of benefit. Perhaps this was due to their lack of knowledge and skills and as a result, they failed to exploit the affordances of Educational Technologies for Creative Teaching.

After the intervention programme, it was releveled that the teachers had gained knowledge and skills relating to the incorporation of Educational Technologies to improve their classroom practices. At the end of the programme, the teachers were able to conduct the selection process with much more focus and understanding in regard to achieving the desired lesson objectives. The teachers pointed out that the purposeful integration of technologies offers many benefits and if well exploited, can greatly enhance the teaching and learning process in the classroom. The teachers also asserted that based on the experience obtained during the intervention programme, the integration of Educational Technologies was not only a means to an end but must be considered together with other factors such as the content to be taught and the learning objectives.

4.4 WHAT ARE TEACHERS' PERCEPTIONS OF THE IMPACT OF EDUCATIONAL TECHNOLOGIES ON THE UNDERSTANDING AND DEVELOPMENT OF CREATIVE TEACHING SKILLS?

The data regarding this research question was obtained through a semi-structured interview. The interview was guided by five questions.

Question 1: Did the intervention programme presented on Social Constructivism and the Educational Technologies help you with the know-how to identify relevant Technology tool(s) that can be used for lesson designing and lesson presentation?

In terms of Social Constructivism, only one participant indicated that the intervention programme helped him to design and present his lesson plan:

> *Yes, the lessons presented on Social Constructivism and Conceptual Teaching provided valuable insights into identifying relevant Technology for lesson planning and presentation. Social Constructivism emphasises collaborative learning and the use of Technology to enhance social interaction and understanding.* (Kevin)

Most of the teachers did not touch on the issue of Social Constructivism, and it appears that they did not respond because they did not understand how Social Constructivism influences the teaching and learning process. This coincides with the findings of Barak (2017) that teachers lacked the knowledge on how to infuse Social Constructivism into their classroom practices to enhance the teaching and learning process. However, he stresses that it is paramount for teachers to embrace the Social Constructivism Approach in their classroom practices, particularly when Educational Technologies are integrated (Barak, 2017).

In terms of Educational Technologies, most teachers indicated that the intervention programme helped them to design and present creative lessons:

> *Yes, I learnt that Technology used in lesson presentations should be in line with the particular learning objectives. As a result, before you identify which ICT to use, you must first consider the learning objectives. Additionally, align your teaching*

strategies to the ICT tool you seek to use. Teachers must use Educational Technologies that complement their instructional strategies. (Lebrone)

Yes, it has helped me as a young teacher. Now I can make informed choices with regards to the selection of Educational Technologies for lesson planning and presentation that must be in line with the learning objectives and accommodate learners' different learning styles. (Judith)

Yes, starting with a clear definition of the learning objectives showed that it is important to also consider the unique requirements of the teaching context, taking into consideration aspects like the age of the learners and the resources that are provided to them. Hence, it is critical to investigate different educational Technology possibilities. Then this will make the lesson presentations of quality and beneficial to the learners. (Jolie)

The data indicated that most teachers were helped by the intervention programme on how to select Educational Technologies for designing and presenting creative lessons. The teachers revealed that the selection process of Educational Technologies should be in line with the learning objectives, teaching strategies, different learning styles, age of the learners, teaching context, and availability of resources. This concurred with Al-Maawali (2020) who found that the selection of Educational Technologies is not a random process but rather the principled consideration of the various factors such as content, learning objectives, and learners' learning styles. In addition, Huang et al. (2019a) indicate that the selection process of Educational Technologies involves several principles such as the principle of appropriateness, the principle of authenticity, the principle of cost, the principle of interest, and the principle of organisation and balance. The process encompasses a wide range of modalities, instruments, and tactics to improve teaching and learning rather than being a monolithic approach.

Question 2: Have you learnt anything with regard to the identification and use of Educational Technologies for lesson and activity designing and presentation?

In terms of lesson design and presentation, most teachers indicated that through the intervention programme, they learnt how to conduct the identification process and use the Educational Technologies for presentations:

> *Yes, what I have learnt about selecting and using Educational Technologies is that when determining the educational Technology tools, you want to incorporate into your class, you must first consider the lesson objectives and how you want to present the content. You should also consider how the educational Technology you want to integrate into the lesson will stimulate cooperation and engagement among learners, as well as how it will boost creativity and innovation.* (Lebrone)

> *Yes, educational Technology tools can promote a learner-centred classroom. Educational technological tools are effective in teaching and learning. It can also disrupt the lesson, as most learners get over excited when Technology is integrated in the lesson.* (Judith)

> *Yes, it helped me realise that there is more research in having to create lessons to be presented, unlike when using the traditional way of teaching. Also, it is vital to identify the correct educational Technology tools that will benefit the learners.* (Jolie)

> *Yes, the lessons have contributed to my understanding of the identification and use of Educational Technologies. It helped in terms of which Technology tool to incorporate when preparing for a lesson. Furthermore, Social Constructivism emphasises the role of Technology in collaborative learning environments, and Conceptual Teaching highlights the use of Technology to represent and convey abstract concepts effectively*. (Kevin)

The data indicated that most teachers learnt how to identify and use Educational Technologies for designing and presenting creative lessons. The teachers themselves revealed that the identification and use of Educational Technologies should consider the content to be taught, the learning objectives, collaboration, active participation, creative development, and a learner-centred lesson. This resonates with Papanikolaou et al.

(2017) and Yurtseven Avci et al. (2020) that for the design and presentation of lessons, teachers need to identify and use Educational Technologies that will promote collaboration, interaction, and active participation. In support, Kwangmuang et al. (2021) maintain that Educational Technologies should also be capable of enhancing the development of learners' creativity and innovation.

In terms of the design and presentation of activities, most teachers indicated that through the intervention programme, they learnt how to conduct the identification process and use the Educational Technologies for presentations:

> *Yes, I have learnt that the use of Educational Technologies such as YouTube videos can be a great way to engage learners and support their learning. They can be used to present new information in an engaging way, and they can also be used to provide additional resources for further study. In addition, YouTube videos can be a great way to personalise learning and meet the needs of individual learners. For example, some learners may prefer to watch videos on their own time, while others may prefer to watch them as part of a group discussion. Overall, I have learnt that YouTube videos can be a powerful tool for enhancing learning.* (Jude)

> *Yes, educational Technology tools can promote a learner-centred classroom. It enables one to design and present creative activities that allow learner[s] to collaborate, interact and actively participate in their learning, as well as fostering creativity. However, as much as they can effecting [be effective] in enhancing teaching and learning, educational technological tools can also be disruptive, as most learners tend to be over excited when Technology is integrated in the lesson*. (Judith)

> *Yes, in a nutshell, the use of Educational Technologies has transformed teaching and learning experiences, made them more engaging, interactive, and effective though activities. It offered opportunities for creativity and personalised learning that assisted learners and me in developing crucial 21st-century skills such as Creative Thinking Skills and critical thinking skills.* (Calton)

Yes, it helped me realise that there is more research in having to create lessons to be presented, unlike when using the traditional way of teaching. Also, it is vital to identify the correct educational Technology tools that will benefit the learners and enabling them to respond/perform activities with much ease. (Jolie)

The data indicated that through the intervention programme, most teachers acquired the necessary knowledge and skills for how to identify and use Educational Technologies for designing and presenting activities. The teachers disclosed that the identification and use of Educational Technologies should be organised to promote learners' participation, personalise learning, collaborate, interact, and actively participate, particularly as the learners embark on an activity. Dukuzumuremyi and Siklander (2018) and Rana (2017) highlight those teachers are central to the creative, collaborative, and interactive process, and they are responsible for the planning and realisation of the creative, collaborative inclusive work in the classroom using Educational Technologies. Furthermore, as emphasised by Selfa-Sastre et al. (2022), the application of Educational Technologies across a range of school subjects provides a different, creative, and collaborative process in the classroom.

Question 3: Is the use of Educational Technologies for Creative Teaching important/valuable?

In terms of the value in using Educational Technologies for Creative Teaching, most teachers indicated that through the intervention programme, they learnt to appreciate the value that the use of Educational Technologies brings in presenting creative lessons:

Absolutely, the use of Educational Technologies can be very valuable in Creative Teaching. It can be used to break down barriers to learning, create more inclusive learning environments, and encourage [the] creativity and innovation of learners. By incorporating educational Technology like YouTube into the curriculum, teachers can make learning more accessible, engaging, and relevant for learners of all backgrounds and abilities. In addition, by using Technology to facilitate Creative Teaching, teachers can help learners develop the 21st-century skills that

they will need to succeed in the modern world … Yes, creatively integrating Educational Technologies in the lesson accommodate[s] different learning styles and allow[s] learners to learn independently. (Judith)

Yes, the use of Educational Technologies in Creative Teaching is indeed of great importance and value. Here are a few reasons why. It enhances engagement between the teacher and amongst [learners]; it promotes personalised learning; it promotes creativity; it promotes access to resources; it enhances collaboration and communication between the teacher and learners. (Calton)

*Yes, lessons become more engaging and dynamic as a result of the innovation and involvement it brings about into the learning process. The ability of Educational Technologies to personalise learning, help the teacher to expose learners to an abundance of resources, encourage collaboration, and provide real-life feedback, which enables teachers to encourage critical thinking and creativity from their learners. Additionally, it helps the teachers to enhance the development of learners – the essential digital skills they need to be prepared for the future. Beyond the obvious benefits, using Educational Technologies in Creative Teaching, as teachers, I can design and present lessons that enables [*sic*] learners to collaborate, apply their knowledge to real-world problems, and think creatively and critically, developing a generation of flexible, creative problem-solvers prepared to survive in a world that is always changing.* (Jolie)

The data indicated that most teachers came to acknowledge and appreciate the value of Educational Technologies for Creative Teaching. The teachers disclosed that the use of Educational Technologies, if effectively integrated, becomes valuable in improving teacher's classroom practices and enhancing the teaching and learning process. The use of Educational Technologies enables the teacher to diversify the presentation of lessons, thus catering for learners' different learning styles and promoting different types of learning such as personalised learning and independent learning. The use of Educational Technologies also promotes creativity, access to resources, collaboration and interaction, and active engagement/participation and communication among the learners and

teacher. Furthermore, it enables learners and teachers to do things that they cannot do without the use of Technology. This concurs with the views expressed by Bahari (2023) and Huang et al. (2019a) that the integration of Educational Technologies offers a wide range of benefits and capabilities that encourage motivation and provide engaging, efficient, and effective learning. Furthermore, echoing the views of Bahari (2023) and Huang et al. (2019a), Häkkinen et al. (2017) emphasise that the effective use of Educational Technologies is potent in promoting different types of learning, creativity, collaboration, and interaction.

Question 4: Did the sessions on lesson reflections assist you in your development of Creative Teaching Skills?

In terms of lesson reflections for Creative Teaching development, most teachers indicated that through the intervention programme, reflections on the lessons presented as part of the programme assisted them in developing and polishing their skills in relation to the use of Educational Technologies to design and present creative lessons:

> *Yes, as a teacher, you must reflect on each presentation of a lesson. It is critical to note the lesson's highs and lows. In my case, lesson reflection sessions really assisted me with the development in Creative Teaching. By reflecting on lessons presented, I had to evaluate what worked and what did not work during the lesson in order to improve my teaching approach. Moreover, reflection aids in developing innovative strategies for imparting knowledge to learners in a way that is more relatable and understandable.* (Lebrone)

> *Yes, the reflection sessions were very valuable in helping me develop my skills in Creative Teaching. By reflecting on my lesson, I was able to identify areas for improvement and make changes to my approach. In particular, I learnt about the importance of using a variety of methods to engage learners such as incorporating videos, audio clips, and interactive activities. I also learnt about the value of providing opportunities for learners to apply their knowledge in real-world contexts.*

These insights have helped me to develop more engaging and effective lessons that meet the needs of my learners. (Jude)

Yes, reflecting on the lesson helped me identify different ways I can creatively integrate Technology in the lesson and also maintain teacher and learner engagement. It also helped me to gathering resources and planning future lessons, which promotes creativity, collaboration, and appropriate communication with clear instructions. (Judith)

Yes, the lesson reflection helped me to explore my teaching style and it also assisted in exploring each learner's learning style. I was able to improve, explore, and develop my Creative Teaching Skills using different educational Technology tools. (Kim)

In terms of the lesson reflections, most of the teachers indicated that they were vital for their improvement in presenting creative lessons. The reflections helped them to assess their strengths and weaknesses regarding the use of technologies for lesson presentations. The teachers pointed out that reflecting on their lesson presentations helped in refining their knowledge and skills with regard to the selection and use of Educational Technologies for both the designing and presentation. Moreover, the reflections helped in sharpening their skills on how to link the objectives and instructional strategies throughout the lesson presentation to ensure that collaboration, interaction, and active learning were highly promoted. This process was instrumental in tracing their growth in terms of decision-making during the holistic selection of Educational Technologies from the planning/designing process to the presentation of the lessons. Moreover, it is through this process that the teachers ensured that their lesson planning was learner-centred. Through the reflection process, the teachers revisited the teaching approach and looked at other ways and forms in which to present their lessons using Educational Technologies for better comprehension. Echoing the views of Amhag et al. (2019) and Gunter and Reeves (2017) in addressing the evolving demands of their learners, teachers must not only learn how to use new Educational Technologies but also how to integrate them deeply into their curricula. In addition, Dlamini and Mbatha (2018)

and Tondeur et al. (2016) stress that it is important for teachers to be available to take part in Technology training and put their newly acquired skills into practice.

Question 5: Having presented a series of lessons using Educational Technologies with the aim of developing Creative Teaching Skills, would you say this exercise was fruitful?

In terms of multiple lesson presentations for Creative Teaching development, most teachers indicated that through the intervention programme, the lessons presented as part of the programme assisted them in developing and refining their skills in relation to the use of Educational Technologies to present creative lessons:

> *Yes, it was well worth it because it allowed me as [a] teacher to enhance my Creative Teaching Skills through the integration of Educational Technologies. This exercise helped me get more familiar with the process on how to identify and use Educational Technologies in the classroom. Furthermore, prior to selecting an educational tool to deliver content, as a teacher, you must consider several lesson objectives such as the strengthening of creative and innovative skills, promoting interaction, and collaboration among learners.* (Lebrone)

> *The exercise of presenting multiple lessons with the goal of developing Creative Teaching Skills was very fruitful. It gave me the opportunity to experiment with different approaches and strategies and to see what worked best for my learners. I was able to gain valuable feedback from the facilitator/researcher and from the learners themselves, and I was able to refine my approach over time. In addition, the experience of presenting multiple lessons helped me to build my confidence and sharpen my skills as a creative teacher.* (Jude)

> *Yes, overall, the first lesson had shortcomings such as poor internet connectivity, at [for] which Creative Teaching served as guidance to come with a solution. Firstly, I planned a lesson with simulations, which were downloaded to the local drive away from the internet. Learners were able to see the simulations as videos without the requirement of internet connectivity.* (Calton)

Yes, it gave me an opportunity to use different Educational Technologies, and I was able to see the importance of these Educational Technologies in teaching and learning. Most importantly, I was able to identify which Educational Technologies are appropriate for my classroom and how I can utilise them to benefit my learners. (Kim*)*

Yes, the use of Educational Technologies holds significant importance and value in the teaching and learning process. It can enhance engagement, facilitate interactive learning experiences, and provide dynamic ways to convey information. The integration of Technology aligns with contemporary educational needs and promotes a more interactive and learner-centred approach. (Kevin)

In terms of lesson presentations for the development of creative thinking skills, the consensus is that most of teachers valued and appreciated the experience they had in designing and presenting several lessons using Educational Technologies. The teachers revealed that this process helped them to develop skills and strategies in the use of technologies to improve their classroom practices. Moreover, conducting multiple lessons helped them to become familiar with various technologies and to become proficient in using these technologies in lesson designing and presentation. The integration of Technology offers various ways/platforms to disseminate information and thus enhance the understanding and acquisition of knowledge. In addition, Technology makes it possible to design and present creative lessons and access cognisant learners' learning styles, among other factors. This resonates with the view of Beardsley et al. (2021) that through the continual use of Educational Technologies, teachers can improve their preparations for lesson plans and present lessons more creatively, effectively, and efficiently in a classroom. In support, Vongkulluksn et al. (2018) declare that teachers are more willing to integrate Technology into their lessons when they think it is valuable. Additionally, Joo et al. (2018) proclaim that teachers who see the value in technologies are more inclined to use them in their classrooms.

4.4.1 Summary

The teachers showed a lack of understanding in regard to Social Constructivism and teaching/learning theory. Most of the teachers could not give a detailed account when they were asked about it. On Technology Integration, teachers displayed a positive attitude, reliance, and confidence in the whole process concerning its effective integration for Creative Teaching in the classroom (e.g., what needs to be considered during the designing of lessons and activities and the presentation of lessons). At the end of the intervention programme, the teachers appreciated and valued Educational Technologies based on what they can bring for both teaching and learning in the classroom. Reflecting on their lesson presentations helped the teachers to refine their skills and identify their strengths and weaknesses. As such, this generated much gratification for their growth and development regarding the use of Educational Technologies for Creative Teaching in their classrooms.

4.5 SUMMARY OF THE FINDINGS

This study was aimed at exploring the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. Firstly, the study found that Technology teachers are not using Educational Technologies to design and present their creative lessons as is expected in the digital age. The reason may be fuelled by various factors such lack of resources, being technophobic and lack of proper training. Secondly, the study found that Technology teachers lacked the knowledge and skills on how to integrate Educational Technologies to enhance their Creative Teaching in a Technology classroom. Thirdly, after a series of lessons were planned and presented, the teachers in this study found that teachers Creative Teaching Skills could be improved or developed through skills development programmes. Their perceptions were transformed during the intervention.

The research findings regarding two of the four research questions are summarised below.

4.5.1 Technology teachers' knowledge and understanding of various Educational Technologies and approaches used in designing and presenting creative lessons before and after training

As indicated earlier in chapter three section **3.7.1**; responding to RQ1 data were collected pre and post the group interviews. The gathered data related to the teachers' knowledge and understanding of various Educational Technologies and approaches that are used in designing and presenting creative lessons. The collective findings to this question indicated various noteworthy events in the participants' experiences. During the pre-training group interview, the first finding was that Educational Technologies are underused by teachers in their classroom practices. It was clear that most teachers do not use or integrate Educational Technologies into their classroom practices as often as is expected in the 21st century. This was particularly evident when most of the teachers revealed that if they do integrate Technology tool(s), they usually resort to laptops/tablets to present PowerPoint slides. Falling within the views expressed by Mynaříková and Novotný (2020) that although there is a repertoire of Educational Technologies available to teachers in this digital age, the technologies are still not widely used in the classroom.

The second finding was that the teachers lack or have limited knowledge, skills, and understanding of how to integrate/use Educational Technologies for both designing and presenting creative lessons. This was evident in their responses; most of the teachers showed incoherence about the factors that influence their choices during the selection process of the Educational Technologies to be used/integrated. Resonating with the views of Ekberg and Gao (2018) that one of the main reasons that teachers are unwilling to integrate Educational Technologies is that they lack the knowledge and expertise to incorporate them into their classroom effectively.

The data collection process of the post-intervention interviews revealed the third finding that teachers' skills and knowledge of the effective integration of Educational Technologies can be developed. In their statements, it was clear that most teachers had gained knowledge and skills for effective integration, and this had resulted in them presenting creative lessons. This was particularly evident, as most of the teachers

disclosed that the intervention programme offered by the researcher had in a way, revealed and facilitated many possibilities. At the end of the intervention programme, teachers were confident in rationalising their selection of Educational Technologies for both designing and presenting creative lessons. This in agreement with Keengwe (2018) and Huda et al. (2017) that in the current technological era, it is imperative that teachers promptly expand their knowledge and skills sets regarding the integration of Educational Technologies into their classroom practices. In support, Carpenter (2019) emphasises that the continual development of skills and knowledge on the integration of Educational Technologies will ensure that teachers keep up with the everchanging world of Technology and be comparable with the rest of the world.

The teachers also revealed that through the intervention programme with the designing, redesigning, and presenting multiple lessons, they have the erudition to embrace, appreciate, and value the affordances that Educational Technologies have to offer. It was through the intervention programme and the integration of Educational Technologies such as the laptop, projector, PowerPoint, YouTube videos, simulations, and animations that the teachers mastered Creative Teaching and facilitated productive and effective teaching and learning experiences. Moreover, through the intervention programme, the teachers acquired the much-needed knowledge and skills on how to teach creatively using various Educational Technologies. Through their participation in the intervention programme, the teachers gained competence and the required skills for using Educational Technologies for Creative Teaching. The intervention programme included the planning and presentation of a series of creative lessons through integrating various Educational Technologies. This is in line with the view expressed by Das (2019) that teachers must receive timely training for the development and application of technological abilities since they play a decisive role in choosing what to teach and how to teach it using Educational Technologies. As stated by Camilleri and Camilleri (2017), it is imperative that teacher-training institutions offer programmes that provide opportunities for skills development in Educational Technologies. Additionally, Collins and Halverson (2018) pose that these opportunities should help teachers develop the mind set to embrace the

use of Educational Technologies and find simple methods to incorporate them into their regular teaching practices.

4.5.2 Teachers' perceptions of the impact of Educational Technologies and their understanding and development of Creative Teaching Skills

As indicated previously in chapter three section **3.7.2**; responding to RQ2 semi-structured interviews were used to gather data on teachers' perceptions of the impact of Educational Technologies and their understanding and development of Creative Teaching Skills. During the interviews, the participants' chronicles uncovered that their teaching experiences were enhanced with the integration of Educational Technologies and improvements were seen. This perspective became a major contributing factor to the use of Educational Technologies for Creative Teaching and learning in their classrooms. The teachers replicated the good practices demonstrated in the intervention programme offered by the researcher. The Educational Technologies enabled strategies and techniques for the Creative Teaching of Technology to be implemented in their classrooms. This influenced their perceptions, attitudes, and beliefs about the use of Educational Technologies to create appropriate teaching and learning experiences for themselves and the learners in their classrooms. As expressed by Dinc (2019), Adegbenro et al. (2017), and Lawrence and Tar (2018), teachers' attitudes and beliefs are crucial in their decision to integrate Educational Technologies consistently into their classroom practices.

4.6 SUMMARY OF THE CHAPTER

This chapter presented the data relating to RQ1 and RQ2 that were gathered through various instruments. The chapter also provided a discussion of the findings. The researcher summarised the findings from the study with reference to the two research questions. This was done by presenting the highlights of the group interviews before and after training on Technology teachers' knowledge and understanding of various Educational Technologies and approaches used in designing and presenting creative lessons. It was also achieved through determining teachers' perceptions on the impact of

Educational Technologies and their understanding and development of Creative Teaching Skills.

The next chapter presents the data that were informed by RQ3 and RQ4 and gathered through various instruments. Furthermore, Chapter 5 provides detailed discussions of the study fundings and each set of findings in relation to the data-collection tool addressing both abovementioned research questions.

CHAPTER 5: PRESENTATION AND DISCUSSION OF FINDINGS FOR RESEARCH QUESTION 3 AND 4

5.1 INTRODUCTION OF THE CHAPTER

The previous chapter focused on the presentation of the discussion of the findings obtained for RQ1 and RQ2. The study presented the data from the group interviews pre and post the intervention and the semi-structured interviews that were informed by RQ1 and RQ2.

This chapter presents the discussion of the findings of the data obtained through various instruments and informed by the research questions outlined in chapter 1. A set of four research questions informed the acquisition and the presentation of the data in addition to the discussion of the findings. Each research question linked to one research data-collection tool. However, for this chapter, the presentation of the data and the discussion of the findings focused mainly on RQ3 and RQ4. To respond to RQ3, the data were collected through document analysis (lesson plans) and non-participant observation. To respond to RQ4, the data were collected through document analysis (activities) and non-participant observation.

5.2 HOW DO TECHNOLOGY TEACHERS USE EDUCATIONAL TECHNOLOGIES TO DESIGN CREATIVE LESSONS AND CREATIVE ACTIVITIES?

This question was addressed through the analysis of the lesson plans and the activities that were designed by the teachers. The two instruments that were used to collect the data are discussed in this section.

5.2.1 Designing creative lessons and creative activities

Seven lesson plans gathered from seven teachers from different rural schools in the Limpopo province were used to extract data in this research. As part of the intervention programme, the researcher gave the teachers the activity to design a creative lesson. However, the teachers were not provided with a template to follow since they were all

practising as teachers at the time of the study. The extraction of data for the first part of the document analysis was from the lessons designed by the teachers and guided by the following components: topic, learning objectives, activity, integration of Technology, and assessment (Astarina, 2020). See Table 3.4.

The second part of data mining focused deeply on the designed activities. To some extent in lesson designing, learner activity is one of the components that is highly considered as part of lesson planning. The activity to be designed was expected to cover certain aspects. Data were extracted from the teachers' designed activities that were guided by the components identified by De Hei et al. (2016); these were relevance of topic and relevance of learning objectives.

The data in this section is presented using a table that is divided into two sections. The first section focuses on the presentation of the data that were extracted from the lesson plan, covering how IPK and INK would be entertained during the lesson presentation. The second section focuses deeply on the learners' activity within the lesson plan, covering how the COK would be entertained during the lesson presentation. Since there were seven participating teachers, seven tables are presented under this segment of the study. Each table focuses on one lesson plan and activity designed by the teacher at the time.

Teacher 1 (lesson plan): Levers				
No.	**Component**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined.
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and is closely linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in the form of a class activity, and it is well linked with the topic.
6.	Are instructional strategies outlined for teaching and learning activities?	✓		Instructional strategies are well stated and resonate with learning objectives. Moreover, they cater for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		This aspect is well catered for through a question-and-answer method as an instructional strategy that is to be used as part of the lesson introduction using examples/scenarios to which learners can relate.
7.2	Allow learners to interact with prior knowledge in a previous lesson	✓		A set of semi-structured questions are outlined that will be used by the teacher to recap and elicit the knowledge of the learners about gears and levers from their previous lesson.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		The outlined set of semi-structured questions is not limited to recapping on the previous class or even the previous grade since the topic was covered in the previous grade, thus catering for this aspect well.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		In the presentation of the advance information on levers, examples and explanations of concepts are provided, which clearly indicates that the teacher will use examples of tools/mechanism to which learners can relate in order to cater for this aspect.
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		To present the advance knowledge on levers, it is indicated that various technologies will be used to disseminate information for better comprehension of the information (e.g., YouTube videos and PowerPoint slides in tandem).
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be further engaged through exercises provided by the teacher as part of the learners' acquisition of new information about levers. The exercises, which are provided in conjunction with

				the instructional strategies, afford a platform for discussion and feedback, thus covering this aspect very well.
Activity				
No.	**Component**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing learners to be active in their learning.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in performing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promote the interaction of learners. Therefore, since it is a group activity, learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured, using information to which learners can relate.
7.	**Does the activity through the integration of Educational Technologies cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities	✓		As part of completing the activity, it is clearly stipulated that the activity will be done in groups and that the teacher will be moving around the groups, guiding and assisting learners by creating Socratic dialogue and affording a platform for discussion and the provision of feedback. It is indicated that a YouTube video will be played for the learners, followed by a slide with questions for learners to respond to in relation to what they have learnt or what was presented on the video, thus linking to a number of the aspects that will have been covered during the lesson presentation and covering this aspect very well.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon	✓		Through Socratic questioning by the teacher, learners will be encouraged to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding. This aspect is covered very well.
7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		As part of the activity, it is clearly stipulated as part of the instructional strategies that learners will be required to present their responses to the rest of the class and respond to any questions that may arise in the class during the presentation, thus covering the aspect very well.

Teacher 1 Lesson:

- Firstly, in his designed lesson, the teacher explicitly outlined the following aspects: topic, objectives outlined, activity, Educational Technologies, assessment, and instructional strategies. The topic, objectives, and activity were well linked, as they must. Furthermore, assessment was in the form of a class activity, and it was well linked with the topic. Moreover, the instructional strategies were well stated and resonated well with the learning objectives, catering for the integration of Educational Technologies. However, although the integration of Educational Technologies was available, it was not clearly stated how it was going to be used during the lesson presentation.
- Secondly, the question of how well the integration of Educational Technologies caters for IPK in a real-life context from a previous lesson in the previous grade was addressed. The aspects were well catered for through a question-and-answer method as an instructional strategy that the teacher aimed to use to extract knowledge about what the learners knew in relation to the topic of levers, making use of examples/scenarios to which the learners could relate. Furthermore, a set of semi-structured questions were outlined that would be used by the teacher to recap and elicit knowledge of the learners about levers from their previous lesson. Because of its flexibility, the outlined set of semi-structured questions was not limited to recapping on the previous class since the topic had been previously covered in the previous grade.
- Thirdly, the question of how well the integration of Educational Technologies caters for INK in a real-life context was addressed through allowing the learners to exchange, debate, and negotiate ideas actively within their groups in a way that increased the learners' interest in learning and allowed the learners to apply themselves as they tried to get clarification and understand the concepts. The aspects in this category were well catered for. It was clearly explained how the presentation of advance information on levers using Educational Technologies would be carried out during the lesson presentation. To cater for this aspect, it was clearly indicated that the teacher would use examples of tools/mechanisms to which the learners could relate. Furthermore, to present the advance knowledge on levers, it was indicated that

various technologies would be used to disseminate the information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem). Moreover, as part of the knowledge presentation, it was clearly outlined how the teachers would engage the learners further in the activity, promoting the acquisition of new information about levers. The provided exercises in conjunction with the instructional strategies afforded a platform for discussion and feedback.

Teacher 1 Activity:

- Firstly, regarding the aspects in his design of links with the topic and objectives, it was clearly noted that the activity had been well linked with the topic to be taught and had covered all that was to be achieved in relation to the objectives.
- Secondly, with regard to the promotion of different types of learning such as active learning, collaborative learning, interactive learning, and real-life context learning, these aspects were well covered in the activity that was designed using a range of Educational Technologies. These were used in conjunction with proper instructional strategies that sought to facilitate the class and promote active learning. For instance, grouping the learners promoted collaboration and interaction because it provided a platform where the learners could debate, discuss, ask each other questions, etc. Moreover, the activity was structured using information and examples that learners could relate to, thus bringing context into their learning.
- Thirdly, on the question of how the activity, through the integration of Educational Technologies, catered for learners' COK, the activity demonstrated learners displaying what they already knew and building further on new knowledge. In addition, it involved the teachers providing the learners with a platform where they could appreciate and comprehend diverse interpretations, including those delivered through technological media, and adopt these in arriving at their own interpretations of the phenomenon. It also involved allowing learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. These aspects were well catered for. In completing the activity, it was clearly stipulated that the activity would be done in groups and that the teacher, as facilitator, would be moving around the groups, guiding and assisting the learners by creating Socratic dialogue and affording a platform for

discussion to take place and to provide feedback. Furthermore, it is indicated that a YouTube video would be played for the learners, followed by a slide with questions for the learners to respond to in relation to what they had learnt or what was presented in the video, linking to several aspects covered during the lesson presentation. Moreover, through Socratic questioning by the teacher, the learners would be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding. Lastly, it was clearly stipulated as part of the instructional strategies that the learners would be required to present their responses to the rest of the class and respond to any questions that may arise in the class during the presentation, thus covering the aspect very well.

Teacher:2(lesson plan): Gears				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined.
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and is closely linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in the form of a class activity, and it is well linked with the topic.
6.	Are instructional strategies outlined for teaching and learning activities?	✓		Instructional strategies are well stated and resonate with the learning objectives. Moreover, they cater for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		This aspect is well catered for through a question-and-answer method as an instructional strategy to be used by the teacher during lesson presentation. The question-answer method formed part of the lesson introduction, recapping on what was done in the previous grade and making use of examples/scenarios while considering the context of the learners.
7.2	Allow learners to interact with prior knowledge from a previous lesson		✓	The topic was addressed in the previous grade, and this lesson is an introduction of the topic in the current grade, hence noting the prior knowledge from the previous lesson in the current grade.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		This aspect is catered for using a set of semi-structured questions that will be used by the teacher to recap and to elicit the learners' knowledge about gears from their previous lesson in the previous grade.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		This aspect is well catered for; it is clearly shown how the teacher is to carry out the presentation of the advanced information about gears through providing scenarios, examples, and explanations of concepts to which the learners can relate. It is clearly indicated that the teacher will use examples of tools/mechanisms that the learners are familiar with (e.g., wine/tin opener, hand drill, eggbeater, gate motor).
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		Catering for this aspect, the plan shows that the teacher will make use of various Educational Technologies to disseminate the information for better comprehension

				(e.g., smartphone, laptop, and smartboard to display YouTube videos and PowerPoint slides in tandem).
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be engaged further through exercises designed by the teacher as part of their acquisition of new information about gears. The exercises that are provided, in conjunction with the instructional strategies, afford a platform for discussion and feedback, thus covering this aspect very well.
		Activity		
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing learners to be active in their learning
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in doing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promote the interaction of learners. Therefore, since it is a group activity, learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which the learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities	✓		As part of completing the activity, it is clearly stipulated that the activity will be done in groups and that the teacher will be moving around the groups while guiding and assisting learners by creating Socratic dialogue, affording a platform for discussion and providing feedback. It is indicated that a YouTube video will be played for the learners, followed by a slide with questions for learners to respond to in relation to what they have learnt or what was presented on the video, thus linking to a number of the aspects that will be covered during the lesson presentation and covering this aspect very well.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon	✓		Through Socratic questioning by the teacher, the learners will be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding, thus covering this aspect very well.

7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		It is clearly stipulated as part of the instructional strategies that learners will be required to present their responses to the rest of the class and to respond to any questions that may arise in the class during the presentation, thus covering the aspect very well.

Teacher 2 Lesson:

- Firstly, his designed lesson explicitly outlined the following aspects: topic, objectives, activity, Educational Technologies, assessment, and instructional strategies. The topic, the objectives, and the activity were well linked. Furthermore, the assessment in the form of a class activity and a home activity was also well linked with the topic. Moreover, the instructional strategies were well stated, resonated well with the learning objectives, and catered for the integration of Educational Technologies. In addition, the integration of Educational Technologies was evident, and it was clearly stated how they were going to be used during the lesson presentation.
- Secondly, on the question of how well the integration of Educational Technologies caters for IPK in a real-life context from a previous lesson in the previous grade, the aspects in this category were well catered for through a question-and-answer method as an instructional strategy. The method was to be used as part of the lesson introduction in addition to recapping on what was done in the previous grade and making use of examples/scenarios while considering the context of the learners. The questions that were to be used by the teacher to recap and elicit the knowledge of the learners about gears from their previous lesson in the previous grade were outlined. However, IPK from a previous lesson was not a focus since the topic had been addressed in the previous grade and this lesson was an introduction of the topic in the current grade.
- Thirdly, on the question of how well the integration of Educational Technologies caters for INK in a real-life context; allows learners to exchange, debate and negotiate ideas actively within their groups in a way that increases their interest in learning; and allows learners to apply themselves as they try to get clarification and understand the concepts, these aspects were well catered for. It was clearly shown that the teacher should carry out the presentation of the advance information about gears through providing scenarios, examples, and explanations of concepts to which the learners could relate. It was clearly indicated that the teacher would use examples of tools/mechanisms with which the learners were familiar (e.g., wine/tin opener, hand drill, eggbeater, gate motor). Furthermore, in catering for these aspects, the plan showed that the teacher would make use of various Educational Technologies to

disseminate the information for better comprehension (e.g., smartphone, laptop, and smartboard to display YouTube videos and PowerPoint slides in tandem). Moreover, as part of the knowledge presentation, it was clearly outlined how the learners would be further engaged through exercises designed by the teacher as part of the learners' acquisition of new information about gears. These exercises in conjunction with the instructional strategies afforded a platform for discussion and feedback.

Teacher 2 Activity:

- Firstly, focusing on the aspects of the links with the topic and the objectives, it was clearly noted in the design of his lesson plan that the designed activity had been well linked with the topic to be taught and had covered all that was to be achieved in relation to the objectives outlined in the lesson.
- Secondly, in regard to the promotion of different types of learning such as active learning, collaborative learning, interactive learning and real-life context learning, these aspects were not fully covered. However, the use of Socratic questioning/dialogue as an instructional strategy that seeks to facilitate the class and forces learners to be active in their learning catered for the first and last aspect very well. Furthermore, the activity was structured using information/examples to which the learners could relate. However, for the second and third aspects, it was difficult to determine how these aspects would be promoted in the absence of an instructional strategy for the activity. Moreover, the activity that was provided did not have the potential to promote these aspects and because of the absence of an instructional strategy, it is difficult to tell how the aspects would be covered.
- Thirdly, the question of how the activity, through the integration of Educational Technologies, catered for learners' COK was addressed. This encompassed the learners displaying what they already know and further building on new knowledge; providing learners with a platform where they could appreciate and comprehend diverse interpretations, including those delivered through technological media, and adopting these in arriving at their own interpretations of the phenomenon. In addition, it allowed learners to think creatively and reflect more deeply and meaningfully so that they could assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. These aspects were catered for but not to a satisfactory level.

Regarding the first aspect, through Socratic questioning by the teachers as an instructional strategy, the activity afforded the learners the platform to engage in what they knew about pulleys as the topic of interest. However, in the absence of an instructional strategy, it is difficult to comprehend how the last two aspects were catered for.

Teacher 3 (lesson plan): Resistance				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined.
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and is closely linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in a form of class activity, and it is well linked with the topic.
6.	Are instructional strategies outlined for teaching and learning activities?	✓		Instructional strategies are well stated and resonate with the learning objectives. Moreover, they cater for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		This aspect is well catered for through a question-answer method as an instructional strategy that is to be used by the teacher during lesson presentation. The question-answer method, as part of the lesson introduction, and recapping on what was done in the previous grade on the importance of electricity in one's daily life is in a manner to which learners can relate.
7.2	Allow learners to interact with prior knowledge from a previous lesson	✓		This aspect is catered for through a set of semi-structured questions. The questions are clearly outlined and will be used by the teacher to recap and elicit the knowledge of the learners about electricity from their previous lesson.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		This aspect is to be catered for using a set of semi-structured questions. The questions are outlined and will be used by the teacher to recap and elicit the knowledge of the learners on electricity from their previous lesson in the previous grade.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		This aspect is well catered for; it is clearly shown how the teacher is to carry out the presentation of the advanced information about resistance through providing scenarios, examples, and explanations of concepts to which learners can relate. It is clearly indicated that the teacher will make use of household appliances as examples that will provide explanations about resistance (e.g., hair dryer, two plate stove, blender).
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		In catering for this aspect, the lesson plan shows that the teacher will make use of various Educational Technologies to disseminate information for better comprehension

				(e.g., laptop, whiteboard to display YouTube videos, simulations, and PowerPoint slides).
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be further engaged using classroom exercises designed by the teacher as part of their acquisition of new information about resistance. The exercises that are provided in conjunction with the instructional strategies afford a platform for discussion and feedback, thus covering this aspect very well.
		Activity		
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing learners to be active in their learning.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in doing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promotes the interaction of learners. Therefore, since it is group activity, the learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities.	✓		To cater for this aspect, the lesson plan shows that an activity will be provided for the learners. As part of completing the activity, it is clearly stipulated that the activity will be done in groups and that the teacher will be moving around the groups, guiding and assisting the learners and asking relevant questions to enable the learners to discuss, debate, and provide feedback. It is indicated that a YouTube video will be played for the learners, followed by a slide with questions for the learners to respond to in relation to what they have learnt or what was presented in the video, thus linking to several aspects covered during the lesson presentation.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon.	✓		Through Socratic questioning by the teacher, the learners will be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding, thus covering this aspect very well.

7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge.	✓		To cater for this aspect, it is clearly stipulated as part of the instructional strategies that the learners will be required to share their responses with the rest of the class. This will be guided by the teacher who will randomly pick a group.

Teacher 3 Lesson:

- Firstly, her designed lesson explicitly outlined the following aspects: topic, objectives, activity, Educational Technologies, assessment, and instructional strategies. The topic, objectives, and activity were well linked, which was a must. Furthermore, assessment in the form of a class activity was also well linked with the topic. However, although the integration of Educational Technologies was available it was not clearly stated how the technologies were going to be used during the lesson presentation. In addition, the instructional strategies were not clearly stated. Hence, it was difficult to follow how the lesson was to be facilitated from the beginning to the end.
- Secondly, for the question of how well the integration of Educational Technologies catered for IPK in a real-life context from a previous lesson in the previous grade, the aspects in this category were well catered for through a question-answer method as an instructional strategy to be used by the teacher as part of the lesson introduction and through recapping on what was done in the previous lesson on the importance of electricity in one's daily life in a manner to which the learners could relate. Furthermore, these aspects were catered for through a set of semi-structured questions. The questions were clearly outlined and would be used by the teacher to recap and elicit the knowledge of the learners regarding electricity from their previous lesson.
- Thirdly, on the question of how well the integration of Educational Technologies catered for INK in a real-life context, it allowed the learners to exchange, debate, and negotiate ideas actively within their groups in a way that increased the learners' interest in learning and also allowed the learners to apply themselves as they tried to get clarification and understand the concepts. The aspects in this category were well catered for, and it was clearly shown how the teacher was to carry out the presentation of the advance information about resistance through providing scenarios, examples, and explanations of concepts to which the learners could relate. It was clearly indicated that the teacher would make use of household appliances as examples to provide explanations about resistance (e.g., hair dryer, two plate stove, blender). Furthermore, in catering for these aspects, the lesson plan showed that the teacher would make use of various Educational Technologies to disseminate information for

better comprehension (e.g., laptop and a whiteboard to display YouTube videos, simulations, and PowerPoint slides). Moreover, as part of knowledge presentation, it was clearly outlined how the learners would be further engaged through using classroom exercises designed by the teacher as part of the learners' acquisition of new information about resistance. The exercises, in conjunction with the instructional strategies, afforded a platform for discussion and feedback, thus covering this aspect very well.

Teacher 3 Activity:

- Firstly, in her design focusing on the aspects of links with the topic and the objectives, it was clearly noted that the designed activity had been well linked with the topic to be taught, covering all that was to be achieved in relation to the objectives and resonating with the objectives outlined in the lesson.
- Secondly, in regard to the promotion of different types of learning such as active learning, collaborative learning, interactive learning, and real-life context learning, it was not clear how this would be achieved since the instructional strategies were not stipulated. Although the activity was provided, it was difficult for the researcher to comprehend how these aspects were to be catered for since there were no instructional strategies that were aligned to the activity. However, the teaching and learning activity in the lesson were context based. The teacher used household items to teach the learners how resistors work in electrical components, making it easy for the learners to relate. Moreover, the learner activity was also context based since its questioning was on household appliances.
- Thirdly, for the question of how the activity, through the integration of Educational Technologies, catered for learners' COK, the following aspects were considered: for the learners to display what they already know and further build on new knowledge; to provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt these in arriving at their own interpretations of the phenomenon; and to allow learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. To cater for these aspects, the activity design as a document of interest

showed that an activity would be provided for the learners. As part of completing the activity, it was clearly stipulated that the activity would be done in groups and the teacher would be moving around the groups, guiding and assisting learners through asking guiding questions and enabling learners to discuss, debate, and provide feedback. It was indicated that a YouTube video would be played for the learners, followed by a slide with instructions and questions for learners to respond to in relation to what they have learnt or what was presented in the video and linking to several aspects that would be covered during the lesson presentation. Furthermore, as part of completing the activity, Socratic questioning by the teacher would be implemented as a strategy to force the learners to debate, to convince each other in the process of harmonising their diverse ideas, and to come to an understanding. Moreover, to cater for these aspects, it was clearly stipulated as part of the instructional strategies that the learners would be required to share their responses with the rest of the class. This would be guided by the teacher who would randomly pick a group at the time to present their responses/findings.

Teacher 4 (lesson plan): Ohm's Law				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined.
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and is closely linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?		✓	The integration is not available. Perhaps the teacher did not see the need to define the type of technologies to be used in this lesson clearly or how they were to be used. However, the assumption is that during the presentation, Educational Technologies will be used to present the lesson.
5.	Is an assessment task(s) available?	✓		It is available in the form of a class activity, and it is well linked with the topic.
6.	Are the instructional strategies outlined for teaching and learning activities?		✓	The lesson plan does not reflect the instructional strategies to be used to facilitate the lesson.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		The assumption is that this aspect will be catered for through the question-and-answer method since there is no clear stipulation of instructional strategies, but traces are visible.
7.2	Allow learners to interact with prior knowledge from a previous lesson	✓		This aspect is catered for through a set of semi-structured questions. The questions are clearly outlined and will be used by the teacher to recap and elicit the knowledge of the learners about gears and levers from their previous lesson.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		This aspect is to be catered for using a set of semi-structured questions. The questions are outlined and will be used by the teacher to recap and elicit the knowledge of the learners on electricity from their previous lesson in the previous grade since the topic was also addressed in the previous grade.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		This aspect is well catered for; it is clearly shown how the teacher is to carry out the presentation of the advance information on Ohm's Law through providing scenarios, examples, and explanations of the concepts in a context to which the learners can relate.

8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		In catering for this aspect, the plan shows that the teacher will make use of various Educational Technologies to disseminate information for better comprehension (e.g., laptop and whiteboard to display YouTube videos, simulations, and PowerPoint slides).
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be further engaged using classroom exercises designed by the teacher as part of their acquisition of new information about resistance. The exercises that are provided, in conjunction with the instructional strategies, afford a platform for discussion and feedback, thus covering this aspect very well.
		Activity		
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		Learners are expected to respond to the activity, as the teacher is performing a simulation forcing them to be active participants.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in doing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy that is used for the completion of the activity, promotes the interaction of learners. Therefore, since it is a group activity, learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which the learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities	✓		To cater for this aspect, the plan shows that an activity will be provided for the learners. As part of completing the activity, it is clearly stipulated that the activity will be done in groups and that the teacher will be moving around the groups, guiding and assisting learners and asking guiding questions to enable the learners to discuss, debate, and provide feedback. It is indicated that instructions for the PowerPoint slides, questions for learners to respond to in relation to what they have learnt or what was presented in the video, and simulations during the presentation of advance knowledge about Ohm's Law linking to several aspects will be covered during the lesson presentation.

7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and adopt such in arriving at their own interpretations of the phenomenon.	✓		Through Socratic questioning by the teacher, the learners will be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding, thus covering this aspect very well.
7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		To cater for this aspect, it is clearly stipulated as part of the instructional strategies that learners will be required to present their responses to the rest of the class. This will be guided by the teacher. However, it is not clear how the presentation is to be conducted.

Teacher 4 Lesson:

- Firstly, his designed lesson explicitly outlined the following aspects: topic, objectives, activity, and assessment. The topic, objectives, and activity were well linked, which was a must. Furthermore, assessment in the form of a class activity was also well linked with the topic and learning objectives. However, the lesson plan document did not reflect the instructional strategies that were to be used to facilitate the lesson, making it difficult to determine how the lesson would be facilitated. Again, integration was not available. Perhaps the teacher did not see the need to define the type of technologies that were to be used in this lesson clearly or how they were to be used. However, the assumption was that during presentation, the teacher would use Educational Technologies to present the lesson.
- Secondly, for the question of how well the integration of Educational Technologies catered for IPK in a real-life context from a previous lesson in the previous grade, some of the aspects in this category were well covered and some were poorly addressed. For instance, the questions were clearly outlined and would be used by the teacher to recap and elicit the previous knowledge of the learners about electricity from a previous lesson. This aspect was to be catered for using a set of semi-structured questions. The questions that would be used by the teacher to recap and to elicit the knowledge of the learners about electricity from their previous lesson in the previous grade were outlined since the topic was also addressed in the previous grade. However, the assumption was that this aspect would be catered for through the question-and-answer method since there was no clear stipulation of instructional strategies. However, traces were visible that the first aspect would be catered for through a set of semi-structured questions.
- Thirdly, for the question of how well the integration of Educational Technologies catered for INK in a real-life context, the following aspects were considered: allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning; and allow learners to apply themselves as they try to get clarification and understand the concepts. These aspects were well catered for, as it was clear how the teacher was to carry out the presentation of the advance information on Ohm's Law. In the process, it indicated that the teacher would

provide scenarios, examples, and explanations of concepts in a context to which the learners could relate. Furthermore, in catering for this aspect, the plan showed that the teacher would make use of various Educational Technologies to disseminate the information for better comprehension (e.g., laptop and a whiteboard to display YouTube videos, simulations, and PowerPoint slides). Additionally, as part of the knowledge presentation, it was clearly outlined how the learners would be further engaged through the use of classroom exercises designed by the teacher as part of the learners' acquisition of new information about resistance. The exercises that were to be provided, in conjunction with the instructional strategies, would afford a platform for discussion and feedback, thus covering this aspect very well.

Teacher 4 Activity:

- Firstly, in his design focusing on the aspects of links with the topic and links with the objectives, it was clearly noted that the designed activity was well linked with the topic to be taught, covered all that was to be achieved in relation to the objectives, and resonated with the objectives outlined in the lesson.
- Secondly, in regard to the promotion of different types of learning such as active learning, collaborative learning, interactive learning, and real-life context learning, it was unclear how these aspects were to be covered since the activity lacked instructional strategies, making it difficult to comprehend. In addition, the absence of clear instructional strategies for the activity compromised the coverage of these aspects. However, regarding the aspect of real-life context learning in the activity, some problems in the activity covered this aspect because it was structured in a way to which learners could relate, albeit to a limited extent since the whole of the activity was not structured in such a fashion.
- Thirdly, for the question of how the activity, through the integration of Educational Technologies, catered for learners' COK, the following aspects were considered: for the learners to display what they already know and further build on new knowledge; to provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt these in arriving at their own interpretations of the phenomenon; and to allow learners to think creatively and reflect more deeply and meaningfully so that they can

assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. To cater for these aspects, the activity design, as a document of interest, showed that an activity would be provided for the learners. As part of completing the activity, it was clearly stipulated that the activity would be done in groups and that the teacher would be moving around the groups, guiding, and assisting learners and asking guiding questions to enable the learners to discuss, debate, and provide feedback. It was indicated that PowerPoint slides, with instructions and questions for learners to respond to in relation to what they had learnt or what was presented in the video, and simulations during the presentation of advance knowledge about Ohm's Law were linked to several aspects that would be covered during the lesson presentation. Moreover, as part of completing the activity, through Socratic questioning by the teacher, learners would be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding. Additionally, it was clearly stipulated as part of the instructional strategies that the learners would be required to present their responses to the rest of the class. This would be guided by the teacher. However, it is not clear how the presentations were to be conducted.

Teacher 5 (lesson plan): Electricity systems and control (Ohm's Law)				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		The topic is clearly outlined.
2.	Are the objectives outlined?	✓		The objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		An activity is available, and it is well linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in the form of a class activity, and it is well linked with the topic.
6.	Are the instructional strategies outlined for the teaching and learning activities?	✓		Instructional strategies are well stated and resonate with the learning objectives. Moreover, this aspect caters for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context.	✓		This aspect is well catered for through a question-answer method. This is an instructional strategy that is to be used as part of the lesson introduction, employing examples of electrical home appliances to which learners can relate.
7.2	Allow learners to interact with prior knowledge from a previous lesson	✓		A set of semi-structured questions is outlined. This will be used by the teacher to recap and to elicit the knowledge of the learners about electricity from their previous lesson.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		The outlined set of semi-structured questions is not limited to recapping on the previous class or the previous grade since the topic was previously addressed in the previous grade, thus catering for this aspect well.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		To present the advance information about Ohm's Law using examples and explanations of concepts (voltage, current, and resistance), it is clearly indicated that the teacher will use examples of electrical appliances to which the learners can relate, thus catering for this aspect.
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		To present the advance knowledge on Ohm's Law and to unpack Ohm's Law and complete the exercises, it is indicated that various technologies will be used to disseminate information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem).
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how the learners will be engaged further through a classroom exercise designed by the teacher as part of their acquisition of new information about gears or levers. The exercises that are provided,

				in conjunction with the instructional strategies, afford a platform for discussion and feedback, thus covering this aspect very well.
		Activity		
No.	Components	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing the learners to be active in their learning.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in carrying out the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promote the interaction of learners. Therefore, since it is group activity, learners are expected to debate, discuss, ask each other question, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which the learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities	✓		As part of completing the activity, it is clearly stipulated that the activity will be done in groups, and it is to be completed in two parts (Part 1 and Part 2). Part 1 learners will be expected to address a set of questions based on their knowledge and understanding of Ohm's Law. Part 2 learners will observe the teacher performing a simulation and respond to the same set of questions. Lasty, Part 1 and Part 2 will be harmonised, thus covering this aspect very well.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon.	✓		As part of completing the activity, learners are to harmonise Part 1 and Part 2 under the guidance of the teacher who will be moving around and asking guiding questions, forcing learners to debate, to convince each other in the process of harmonising their diverse ideas, and to come to an understanding, thus covering this aspect very well.
7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		It is clearly stipulated as part of the instructional strategies that the teacher and the learners will engage in a whole-class discussion on the learners' responses and findings, thus covering this aspect very well.

Teacher 5 Lesson:

- Firstly, her designed lesson explicitly outlined the following aspects: topic, objectives, activity, Educational Technologies, assessment, and instructional strategies. The topic, the objectives, and the activity were well linked, which was a must. Furthermore, assessment in the form of a class activity was also well linked with the topic and objectives. Furthermore, the integration of Educational Technologies was available and traces of how the technologies were to be used are clearly visible. The assessment was available in the form of a class activity and was well linked with the topic. Moreover, the instructional strategies were well stated, and they resonated with the learning objectives.
- Secondly, for the question of how well the instructional strategies catered for learners to interact with prior knowledge in a real-life context from a previous lesson in a previous grade, this aspect was well catered for through a question-answer method as an instructional strategy to be used as part of the lesson introduction and employing examples of electrical home appliances to which learners could relate. Furthermore, a set of semi-structured questions was outlined that would be used by the teacher during the question-and-answer method session to recap and to elicit the knowledge of the learners about electricity that was gained from a previous lesson. Lastly, the outlined set of semi-structured questions was not limited to recapping on the previous class or the previous grade since the topic was previously addressed in a previous lesson in a previous grade.
- Thirdly, for the question of how well the instructional strategies catered for INK in a real-life context, the aspects of learners actively exchanging, debating, and negotiating ideas within their groups in a way that increases their interest in learning and applying themselves as they try to get clarification and understand the concepts were well catered for by showing how the presentation of the advance information on Ohm's Law and the provision of examples and explanations of concepts (voltage, current and resistance) would be carried out. Furthermore, it was clearly indicated that the teacher would use examples of electrical appliances to which the learners could relate in order to cater for these aspects. Moreover, to present the advance knowledge on Ohm's Law, it was indicated that various technologies would be used to

disseminate the information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem) in addition to unpacking Ohm's Law and completing the exercises. Moreover, as part of the knowledge presentation, it was clearly outlined how the learners would be further engaged through a classroom exercise designed by the teacher as part of their acquisition of the new information on Ohm's Law. The exercises that would be provided, in conjunction with the instructional strategies, would afford a platform for discussion and feedback.

Teacher 5 Activity:

- Firstly, in her design focusing on the links with the topic and the objectives as some of the aspects of the lesson plan, it was clearly noted that the designed activity was well linked with the topic to be taught, covered all that was to be achieved in relation to the objectives, and resonated with the objectives outlined in the lesson.
- Secondly, regarding the promotion of different types of learning such as active learning, collaborative learning, interactive learning, and real-life context learning, the aspects were well covered in the designed activity through a range of instructional strategies that sought to facilitate the class, forcing learners to be active in their learning. For instance, grouping of the learners promoted collaboration and interaction because ideally, it would provide a platform where the learners would debate, discuss, ask each other questions, etc. Moreover, the activity was structured using information and examples to which learners could relate, thus bringing context to their learning.
- Thirdly, for the question of how the activity, through the integration of Educational Technologies, catered for learners' COK, the following aspects were considered: learners displaying what they already know and building further on new knowledge; and providing learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and adopting these in arriving at their own interpretations of the phenomenon. In addition, the aspect of allowing learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge was appraised. To cater for these aspects, the activity design as a document of interest showed that an activity would be provided for the learners. As part of completing the activity, it was clearly stipulated that the

activity would be done in groups and be completed in two parts (Part 1 and Part 2). In Part 1, the learners would be expected to address a set of questions based on their knowledge and understanding of Ohm's Law. In Part 2, the learners would observe the teacher performing a simulation and respond to the same set of questions. Lastly, Part 1 and Part 2 would be harmonised, thus covering these aspects very well. This would be carried out under the guidance of the teacher as she moved around asking guiding questions, encouraging learners to debate, to convince each other in the process of harmonising their diverse ideas, and to come to an understanding.

Teacher 6 (lesson plan): Hydraulic systems / Pascal's principle				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined.
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and links well with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in the form of a practical class activity, and it is well linked with the topic.
6.	Are instructional strategies outlined for teaching and learning activities?	✓		Instructional strategies are well stated and resonate with the learning objectives. Moreover, they cater for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		This aspect is well catered for through a whole-class discussion as an instructional strategy. The discussion forms part of the lesson introduction and is used to extract learners' prior knowledge of hydraulic systems dating back to ancient times. Examples of the mechanisms to which learners can relate are provided.
7.2	Allow learners to interact with prior knowledge from a previous lesson	✓		A set of semi-structured questions that is to be used by the teacher to inspire the whole class is outlined. These questions are also employed as a way to recap and elicit the knowledge of the learners on hydraulics from a previous lesson in the previous grade.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		The discussion is not limited to recapping on the previous class or even the previous grade since the topic was previously addressed in the previous grade. Moreover, the discussion not only relates to learners' knowledge of hydraulic systems but also to their experiences.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		To present the advance information on hydraulics and Pascal's principle and provide examples and explanations of concepts, it was clearly indicated that the teacher will use examples of tools/mechanisms that learners can relate to in order to cater for this aspect.
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		To present advance knowledge on hydraulic systems / Pascal's principle, it is indicated that various technologies will be used to disseminate information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem).

8.3	To allow learners to apply themselves as they try to get clarifications and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be further engaged through exercises designed by the teacher as part of their acquisition of new information about hydraulic systems / Pascal's principle. The exercises provided in conjunction with the instructional strategies afford a platform for discussion and feedback, thus covering this aspect very well.
		Activity		
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with the topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing the learners to be active in their learning.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in doing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promote the interaction of learners. Therefore, since it is group activity, learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities	✓		As part of completing the activity, it is clearly stipulated that the activity will be done in groups and that the teacher will be moving around the groups, guiding and assisting learners by creating Socratic dialogue. This affords a platform for discussion and feedback. It is indicated that a YouTube video will be played for the learners, followed by a slide with questions for learners to respond to in relation to what they have learnt or what was presented in the video. This is linked to a number of the aspects that will be covered during lesson presentation, thus covering this aspect very well.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon.	✓		As part of completing the practical activity and the Socratic questioning by the teacher, learners will be forced to debate, convince each other in the process of harmonising their diverse ideas, come to an understanding, look for pattens, and draw conclusions, thus covering this aspect very well.

7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		As part of the practical activity, it is clearly stipulated as part of the instructional strategies that learners will be required to present their findings to the rest of the class and respond to any questions that may arise in the class during the presentation, thus covering the aspect very well.

Teacher 6 Lesson:

- Firstly, his designed lesson explicitly outlined the following aspects: topic, objectives, activity, Educational Technologies, assessment, and instructional strategies. The topic, objectives, and activity were well linked, which was a must. Furthermore, the assessment in the form of a class activity was also well linked with the topic and the objectives. Additionally, the integration of Educational Technologies was available and traces of how the technologies were going to be used are clearly visible. The assessment, also available in the form of a class activity, was well linked with the topic. Moreover, the instructional strategies were well stated and resonated with the learning objectives.
- Secondly, the aspects of how well the instructional strategies catered for learners IPK in a real-life context from a previous lesson in a previous grade were well catered for through a whole-class discussion as an instructional strategy. This discussion was to be used as part of the lesson introduction and to extract and recap on learners' previous knowledge of hydraulic systems dating back to ancient times. Examples of the mechanisms to which the learners could relate were provided. As such, a set of semi-structured questions was outlined that would be used by the teacher to inspire the whole class and to recap and elicit the learners' knowledge of hydraulics from a previous lesson in their previous grade. However, the discussion was not limited to recapping on the previous class or even the previous grade. Since the topic had been previously addressed in the previous grade, it was also open to catering for learners' knowledge of their experiences outside the school setting.
- Thirdly, for the question of how well the instructional strategies allow learners to interact with new knowledge in a real-life context; to exchange, debate, and negotiate ideas actively within their groups in a way that increases their interest in learning; and to allow learners to apply themselves as they try to get clarification and understand the concepts, these aspects were well catered for through the presentation of the advance information on hydraulics and the Pascal's principle. Through the provision of examples and explanations of concepts, it was clearly indicated that the teacher would use examples of tools/mechanisms to which

learners could relate in order to cater for these aspects. Furthermore, to present the advance knowledge on hydraulic systems / Pascal's principle, it was indicated that various technologies would be used to disseminate the information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem). As part of the knowledge presentation, it was clearly outlined how the learners would be further engaged through exercises designed by the teacher as part of their acquisition of new information about hydraulic systems / Pascal's principle. The exercises would be provided in conjunction with the instructional strategies to afford a platform for discussion and feedback, and the instructional strategies to be used would facilitate both the teaching and the learning activities, thus covering this aspect very well. Furthermore, the nature of the activity provided for the learners was in the context of the learners and also related to the YouTube video that was projected before the learners embarked on the activity in their respective groups. Moreover, the nature of the activities that were provided in conjunction with the instructional strategies for facilitation catered for these aspects well since the learners worked in groups. Again, to cover these aspects, the activity that was provided in conjunction with the instructional strategies afforded a platform for the learners to discuss, debate, and provide feedback.

Teacher 6 Activity:

- Firstly, in his design focusing on the links with the topic and the objectives of some of the aspects of the lesson plan, it was clearly noted that the designed activity was well linked with the topic to be taught, covering all that was to be achieved in relation to the objectives. Moreover, the activity resonated with the objectives that were outlined in the lesson. Moreover, the range of instructional strategies that sought to facilitate the class ensured that the learners took an active role in their learning.
- Secondly, in regard to the promotion of different types of learning such as active learning, collaborative learning, interactive learning, and real-life context learning, this aspect was well covered in the activity that was designed through a range of instructional strategies that sought to facilitate the class by ensuring that the learners played an active role in their learning. For instance, the grouping of the

learners promoted collaboration and interaction because ideally, it provided a platform where the learners could debate, discuss, ask each other questions, etc. Moreover, the activity was structured using information and examples to which learners could relate, thus bringing context to their learning.

- Thirdly, for the question of how well the use of Educational Technologies catered for COK, the following aspects were considered: to allow learners to display what they already know and further build on new knowledge through design activities; to provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt these in arriving at their own interpretations of the phenomenon; and to allow learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. The aspects in this category were catered for through the completion of a practical activity, and it was clearly stipulated that the activity would be done in groups. As the learners were completing the practical activity, the teacher would be moving around the groups, guiding and assisting the learners by creating Socratic dialogue to afford a platform for discussion and to provide feedback. Moreover, it was indicated that a YouTube video would be played for the learners, followed by a slide with questions for learners to respond to in relation to what they had learnt or what had been presented on the video, linking to a number of the aspects that would be covered during the lesson presentation. Furthermore, as part of completing the practical activity, Socratic questioning by the teacher forced the learners to debate, to convince each other in the process of harmonising their diverse ideas, to come to an understanding, to look for pattens, and to draw their conclusions. Additionally, as part of the practical activity, it was clearly stipulated as part of instructional strategies that learners would be required to present their findings to the rest of the class and respond to any questions that may arise in the class during the presentation.

Teacher 7 (lesson plan): Pulleys				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Is the topic outlined?	✓		Topic is clearly outlined
2.	Are the objectives outlined?	✓		Objectives are clearly outlined and link well with the topic.
3.	Is the activity available?	✓		Activity is available and is closely linked with the topic and the objectives.
4.	Is there an integration of Educational Technologies?	✓		The integration is available, but it is not clearly stated how it is going to be used.
5.	Is an assessment task(s) available?	✓		It is available in the form of a class activity, and it is well linked with the topic.
6.	Are instructional strategies outlined for teaching and learning activities?	✓		Instructional strategies are well stated and resonate with the learning objectives. Moreover, they cater for the integration of Educational Technologies.
7.	**Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction and eliciting prior knowledge)**			
7.1	Allow learners to interact with prior knowledge in a real-life context	✓		This aspect is well catered for through storytelling and the question-and-answer method as an instructional strategy to be used as part of the lesson introduction and the extraction of previous knowledge of pulley systems. The teacher uses examples/scenarios to which learners can relate.
7.2	Allow learners to interact with prior knowledge from a previous lesson	✓		A set of semi-structured questions are outlined and will be used by the teacher to recap and to elicit the knowledge of the learners from their previous lesson on pulley systems.
7.3	Allow learners to interact with prior knowledge from a previous grade	✓		The outlined set of semi-structured questions is not limited to recapping on the previous class or even the previous grade since the topic was previously addressed in the previous grade, thus catering for this aspect well.
8.	**Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)**			
8.1	To allow learners to interact with new knowledge in a real-life context	✓		To present the advance information about pulley systems and provide examples and explanations of concepts, it is clearly indicated that the teacher will use examples of tools/mechanisms to which learners can relate, thus catering for this aspect.
8.2	To allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning	✓		To present the advance knowledge on pulley systems, it is indicated that various technologies will be used to disseminate information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem), unpacking how to solve problems such as determining the load, input forces, etc.
8.3	To allow learners to apply themselves as they try to get clarification and understand the concepts	✓		As part of the knowledge presentation, it is clearly outlined how learners will be further engaged through exercises designed by the teacher as part of their acquisition of new

				information about pulley systems. The exercises provided in conjunction with the instructional strategies afford a platform for discussion and feedback, thus covering this aspect very well.
Activity				
No.	**Components**	**Yes**	**No**	**Researcher's comments**
1.	Does the activity link with topic?	✓		It is well linked and covers all that is to be achieved in relation to the objectives.
2.	Does the activity link with the objectives?	✓		It resonates well with the objectives outlined in the lesson.
3.	Does the activity promote active learning?	✓		There is a range of instructional strategies that seeks to facilitate the class, forcing learners to be active in their learning.
4.	Does the activity promote collaborative learning?	✓		The instructional strategy used in doing the activity promotes the collaboration of learners since it is a group activity.
5.	Does the activity promote interactive learning?	✓		The integrated Educational Technologies, in conjunction with the type of instructional strategy used for the completion of the activity, promote the interaction of learners. Therefore, since it is a group activity, learners are expected to debate, discuss, ask each other questions, etc.
6.	Does the activity promote real-life context learning?	✓		The activity is structured using information to which learners can relate.
7.	**Does the activity, through the integration of Educational Technologies, cater for COK in relation to the following?**			
7.1	Allows learners to display what they already know and further build on new knowledge through design activities.	✓		As part of completing the activity, it is clearly stipulated that the activity will be done in groups and the teacher will be moving around the groups, guiding and assisting learners by creating Socratic dialogue. This will afford a platform for discussion and provide feedback. It is indicated that a YouTube video will be played for the learners, followed by a slide with questions for the learners to respond to in relation to what they have learnt or what was presented on the video, linking to a number of the aspects that will be covered during lesson presentation and thus covering this aspect very well.
7.2	Provides learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of the phenomenon.	✓		Through Socratic questioning by the teacher, learners will be forced to debate, convince each other in the process of harmonising their diverse ideas, and come to an understanding, thus covering this aspect very well.
7.3	Allows learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge	✓		As part of the activity, it is clearly stipulated as part of the instructional strategies that learners will be required to present their responses to the rest of the class and respond to any questions that may arise in the class during the presentation, thus covering this aspect very well.

Teacher 7 Lesson:

- Firstly, her designed lesson explicitly outlined the following aspects: topic, objectives, activity, Educational Technologies, assessment, and instructional strategies. The topic, objectives, and activity were well linked, which was a must. Furthermore, assessment in the form of a practical activity was also well linked with the topic. Moreover, the instructional strategies were well stated, resonated well with the learning objectives, and catered for the integration of Educational Technologies. In addition, the integration of Educational Technologies was available, and it was clearly stated how the technologies were to be used during the lesson presentation.
- Secondly, for the question of how well the instructional strategies catered for learners' IPK in a real-life context from a previous lesson in a previous grade or from experiences, the aspects in this category were well catered for. This was achieved through storytelling, through the question-and-answer method as an instructional strategy to be used as part of the lesson introduction, and through the extraction of previous knowledge of pulley systems, with the teacher using examples/scenarios to which the learners could relate. As such, a set of semi structured questions was outlined that would be used by the teacher to recap and elicit the knowledge of the learners about pulley systems from a previous lesson in their previous grade and from life experiences. Moreover, the outlined set of semi structured questions was not limited to recapping on the previous class or even the previous grade since the topic had been previously addressed in the previous grade.
- Thirdly, for the question of how well the instructional strategies cater for learners' INK in a real-life context, the following aspects were considered: to allow learners to interact with new knowledge in a real-life context; to allow learners to exchange, debate, and negotiate ideas actively within their groups in a way that increases learners' interest in learning; and to allow learners to apply themselves as they try to get clarification and understand the concepts. The aspects in this category were well catered for through the outline of the presentation of the advance information on pulley systems and the provision of examples and explanations of the concepts. It was clearly indicated that the teacher would use examples of tools/mechanisms to which the learners could relate in order to cater for this aspect. Furthermore,

regarding how to present the advance knowledge on pulley systems, for instance, unpacking how to solve problems such as determining the load, input forces, etc., it was indicated that various technologies would be used to disseminate information for better comprehension (e.g., YouTube videos and PowerPoint slides in tandem). Moreover, as part of the knowledge presentation, it was clearly outlined how learners would be further engaged through exercises designed by the teacher as part of their acquisition of new information about pulley systems. The exercises that were provided, in conjunction with the instructional strategies, would afford a platform for discussion and feedback.

Teacher 7 Activity:

- Firstly, in his design focusing on the links with the topic and the objectives as some of the aspects of the lesson plan, it was clearly noted that the designed activity had been well linked with the topic to be taught, covering all that was to be achieved in relation to the objectives and resonating with the objectives outlined in the lesson.
- Secondly, regarding the promotion of different types of learning such as the aspects of active learning, collaborative learning, interactive learning, and real-life context learning, the aspects were well covered in the designed activity through a range of instructional strategies that sought to facilitate the class, forcing the learners to be active in their learning. For instance, grouping of the learners would promote collaboration and interaction because it would ideally provide a platform where learners could debate, discuss, ask each other questions etc. Moreover, the activity was structured using information and examples to which learners could relate, thus bringing context to their learning.
- Thirdly, for the question of how the activity, through the integration of Educational Technologies, catered for learners' COK, the following aspects were considered: learners to display what they already know and further build on new knowledge; provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt these in arriving at their own interpretations of a phenomenon; and allow learners to think creatively and reflect more deeply and meaningfully so that they can assume ownership of their knowledge rather than simply duplicating the teacher's knowledge. These aspects were catered for through an activity. As part of completing the activity, it was clearly stipulated that the activity would be done

in groups and the teacher would be moving around the groups, guiding and assisting the learners by creating Socratic dialogue, thus affording a platform for discussion and the provision of feedback. It was indicated that a YouTube video would be played for the learners, followed by a slide with questions for learners to respond to in relation to what they have learnt or what was presented in the video, linking to several the aspects that would be covered during the lesson presentation. Furthermore, through the Socratic questioning by the teacher, learners would be encouraged to debate, to convince each other in the process of harmonising their diverse ideas, and to come to an understanding. In addition, it was clearly stipulated as part of the instructional strategies for the activity that learners would be required to present their responses to the rest of the class and to respond to any questions that may arise in the class during the presentation.

5.2.3 Teachers' use of Educational Technologies to design creative lessons and activities

5.2.3.1 Interaction with Prior Knowledge

Regarding the document analysis of the lesson plan, most of the teachers covered this category well. They clearly indicated the Educational Technologies that they would use and how they would be used during the lesson presentation. Furthermore, the teachers clearly stipulated the type of instructional strategies to be used to facilitate the lesson. Most of the teachers indicated in their lesson plans that they would use a laptop/tablet/smartphone for their displays on the whiteboard/smartboard. These displays would be either a YouTube video or PowerPoints slides, followed by a question-and-answer method / whole-class discussion to recap and extract learners' knowledge about the topic based on previous experience, be it a previous lesson in the current grade or in the previous grade or an experience outside the school environment. Therefore, it was clear that from their experiences as practitioners and as participants in the intervention programme that teachers were well vested with the knowledge and skills to design creative lesson plans. This reflects the views expressed by Backfisch et al. (2020) that teachers' knowledge of ICT is pivotal in designing lesson plans and purposefully integrating Educational Technologies into their lessons. However, in the current study, there were certain activities for which there were no

instructional strategies to be carried out during the presentations, making it difficult for the researcher to understand how the activities were going to be executed.

5.2.3.2 Interaction with New Knowledge

Regarding the document analysis of the lesson plan, most of the teachers covered this category well. The teachers clearly specified the type of technologies to be used and outlined in detail how they would be used in delivering new information during the lesson presentation. To cater for this category, most of the teachers listed more than one type of Technology to disseminate new information during lesson presentation, for instance, PowerPoint slides for description and 3D pictures. In addition, a YouTube video would be played, outlining the step-by-step approach to problem-solving and complementing the information on the slides. Most of the teachers also presented a detailed account of how this would unfold during presentation of the lesson. Most of the teachers stated that delivery of new information would be through PowerPoint slides, YouTube videos, simulations, and animated videos. In summary, their plan was to employ multiple means of presenting information covering diverse learning styles and other factors. This resonates with the view expressed by Bender (2023) that the use of multiple presentations of information using Educational Technologies propels the way that information is disseminated and consumed in the classroom.

5.2.3.3 Construction of Own Knowledge

Regarding the activity document analysis, most of the teachers covered this category well. The teachers clearly specified the type of technologies to be used and outlined in detail how they would be used in engaging learners in discussions and debates and in allowing the learners to draw their own conclusions during the lesson presentation. Most of the teachers managed to design an activity that would promote integration, collaboration, and learning in context. Concerning their designed activities, most teachers clearly outlined the instructional strategy that they would use to cultivate a learning environment that would enable learners to make their own inferences in relation to the activity. Most teachers opted to use PowerPoint slides, YouTube videos, and simulations for the presentation of the activity. The findings of the current study are in line with the articulation of Larison (2022) that the teacher often becomes a technical advisor, a collaborator in problem-solving, or an agent facilitating group work.

In support of the above, Van Hover and Hicks (2017) indicate that in Social Constructivism, a teacher organises, plans, leads, and gives instructions to the learners.

5.2.4 Summary

Considering section 5.2 above, it is unequivocal that most of the teachers could design creative lesson plans and creative activities. In the lesson plans, the fundamental components of the lesson such as topic and learning objective were well reflected. In terms of designing a lesson plan within the parameters of Social Constructivism, the aspects of IPK, INK, and COK were catered for very well. Most of the teachers provided a detailed account in their designed lesson plans regarding how aspects would be entertained to cover the three categories of Social Constructivism, for instance, indicating the Educational Technologies to enable the learners to complete an activity and the instructional strategy to facilitate the process. Again, in integrating Educational Technologies into their teaching, most teachers opted to use the laptop, projector, and whiteboard/smartboard to display PowerPoint slides, YouTube videos, and simulations for their presentations. However, in some instances, some of the lesson plans that were provided lacked information. For instance, in their lesson or activity designs, a few teachers did not provide instructional strategies or a list of the Educational Technologies that would be used to facilitate the presentation of the lesson. But through reflections and redesigning, this is a habit that can be quelled over time.

5.3 HOW DO TECHNOLOGY TEACHERS USE EDUCATIONAL TECHNOLOGIES TO PRESENT CREATIVE LESSONS?

This question aimed to determine teachers' acquired knowledge and understanding, and their skills development post the researcher's intervention programme. This is in line with the Social Constructivism framework that was employed in this study under the themes IPK, INK, and COK. The data that were extracted during the observations of the classes in which the teachers used Educational Technologies to present their creative lessons are provided in the subsequent sections.

The presentation of the abovementioned data covers the two sessions (cycles) that were observed. A description of the physical layout of the classroom and the resources is initially presented, followed by an outline of the following aspects: topic taught, and lesson presentation guided by the Social Constructivism Theory focusing on IPK, INK, and COK.

Table 4.2: Categories of Social Constructivism for lesson presentation

Interaction with Prior Knowledge	For this category, the lesson presentation focused on the use of various Educational Technologies. The teacher was expected to deliver a lesson to elicit learners' prior knowledge from a real-life context in a previous lesson from a previous learning grade.
Interaction with New Knowledge	For this category, the lesson presentation focused on the use of various Educational Technologies. The teacher was expected to deliver a lesson that would enable the learners to engage in new information in a real-life context; increase the learners' interest in learning through active exchange, debate, and the negotiation of ideas; and allow the learners to apply themselves as they try to get clarification and understand the concepts.
Construction of Own Knowledge	For this category, the lesson presentation focused on the use of various Educational Technologies. The teacher was expected to deliver a lesson that would enable learners to display what they already know and to build further on new knowledge; to appreciate and comprehend diverse interpretations and to arrive at their own interpretations of the phenomenon; and to think creatively and reflect more deeply and meaningfully, taking ownership of their knowledge.

In the following sections, the data that were extracted from the observations of the classes in which the teachers used Educational Technologies to present their creative lessons are discussed. The presentation of the abovementioned data covers the two sessions (cycles) per teacher that were observed. A description of the physical layout of the classroom and the resources is initially presented, followed by an outline of the following aspects: topic taught and presentation of creative lesson, focusing on the use of Educational Technologies to enhance IPK, INK, and COK.

5.3.1 Classroom context

An outline of the classroom layout of the seven classes that were observed by the researcher during the collection of data is presented below:

- **Lebrone's class:** The class consisted of about 55 learners sitting in groups (4−6 learners per group). The classroom did not have a permanent whiteboard or a projector. The teacher brought in the projector, laptop, and the small, mobile whiteboard that could be folded. Before the lesson presentation, the teacher needed to connect all the technologies, which was time consuming.

The setup aimed to transform the classroom environment to enhance Creative Teaching for lesson presentation through Educational Technologies.

- **Jude's class:** The class comprised about 20 learners sitting in groups of four. The class was a smart classroom with a projector, smartboard, whiteboard, and Wi-Fi all permanently installed. The teacher needed to bring a laptop and a smartphone with him. Before the lesson presentation, the teacher connected all the technologies that were to be used, which was quick since everything was in place. The setup created an ideal environment to enhance Creative Teaching for lesson presentation through Educational Technologies.
- **Judith's class:** The class consisted of about 45 learners sitting in groups (4−6 learners per group). The class had a permanent whiteboard but no projector. The teacher needed to bring a laptop, a projector, and a sound speaker with her. Before the lesson presentation, the teacher connected the technologies that were to be used, which was time consuming. The setup aimed to transform the environment to enhance Creative Teaching for lesson presentation through Educational Technologies.
- **Calton's class:** The class comprised about 40 learners sitting in groups (4−6 learners per group). However, the class did not have a whiteboard or a projector. The teacher brought in a projector, a laptop, and a small mobile whiteboard that could be folded. Before the lesson presentation, the teacher connected all the technologies that were to be used in the presentation, which was time consuming. The setup aimed to transform the classroom environment to enhance Creative Teaching for lesson presentation through Educational Technologies.
- **Jolie's class:** The class consisted of about 45 learners sitting in groups (4−6 learners). The class had a permanent whiteboard, but no projector had been installed. The teacher brought a laptop, a projector, and a sound speaker with her. Before the lesson presentation, the teacher connected all the technologies that were to be used for the presentation, which was time consuming. The setup aimed to transform the environment to enhance Creative Teaching for lesson presentation through Educational Technologies.
- **Kim's class:** The class comprised about 48 learners sitting in groups (4−6 learners per group). The class had a permanent whiteboard but no installed

projector. The teacher brought a laptop, a projector, and a sound speaker with her. Before the lesson presentation, the teacher connected all the technologies that were to be used, which was time consuming. The setup aimed to transform the environment to enhance Creative Teaching for lesson presentation through Educational Technologies.

- **Kevin's class:** The class consisted of about 22 learners, sitting in groups of five to six learners per group. The class was a smart classroom and had a projector, smartboard, whiteboard, and Wi-Fi permanently installed. The teacher brought only a laptop with him. Before the lesson presentation, the teacher had to connect all the technologies for his presentation, which was quick since everything was in place. The setup was an ideal environment to enhance Creative Teaching for lesson presentation through Educational Technologies.

5.3.2 Classroom observations

As indicated in Chapter 3, the participants were honours students who were already practising as teachers at the time of the study. One of the modules in the honours programme focused on the use of Educational Technologies in the classroom. Most of the outcomes focused on understanding teachers' ability to use Educational Technologies in their classroom practices after their training on various Educational Technologies and how they work. The teachers were expected to be evaluated through observations on how they creatively teach their classes using various Educational Technologies. However, before training, most of them were not often using effective Educational Technologies that enhance Creative Teaching. This practice develops teachers' Creative Teaching Approach, inspires learners' imagination, and motivates learners to reflect, learn, and introduce new ideas (Harris & De Bruin, 2018). During the observations, the researcher uncovered that the teachers were not using Educational Technologies tools regularly, and learners were more excited by the visual images than motivated to learn and reflect.

As indicated in Chapter 3, the research approach to collect the observation data was done through an action research design. The researcher trained the honours student/teachers on the different types of technologies and how to use them in the

classroom. Hence, the teachers (now students) were expected to conduct their lesson presentations using different technologies under observation, which included a first cycle and a second cycle to check how they were developing their Creative Teaching Skills.

5.3.2.1 Lebrone classroom observations (School A)

The topic for the lesson presentation was based on Mechanical Systems and Control, focusing on levers and gears (mechanical advantage calculations) in a Grade 9 senior-phase Technology classroom. The Educational Technologies used in the lesson presentation were a laptop, a projector, and a whiteboard to display simulation videos on gears and levers in addition to a Word document.

A. First cycle of classroom observation

- *Interaction with Prior Knowledge*

  As he entered the classroom, the teacher greeted the learners and thereafter connected his laptop to a projector to enable him to project his lesson presentation onto the whiteboard. The teacher then displayed a Word document on the whiteboard. The Word document had three sections: the section for prior knowledge, the section for new knowledge, and the section for construction of knowledge. The first section displayed notes recapping on the introduction of levers and gears that was done in the previous lesson. The second section had notes introducing advance knowledge of levers and gears. The third section had an activity covering the topic of levers and gears.

  Using the displayed document, the teacher introduced the lesson, starting with the topic(s) gears and levers and indicating what was to be achieved by the end of the lesson. After the introduction was completed, the teacher engaged the learners through a whole-class discussion about gears. In addition, the teacher projected a simulation video to enhance the learners' understanding of the previous lesson. This was confusing as an observer because it seemed to be a new lesson instead of a recap on the previous lesson as expected. The first simulation video, which was on the topic of levers, projected tools such as the wheelbarrow, hammer, and stapler. The teacher played the video and continually paused it to ask the learners questions about each type of lever. The second simulation video, which was on the

topic of gears, projected machines such as a gate motor, bicycle, and tin opener. The teacher played the video and again, continually paused it to ask the learners questions about each type of gear. The teacher used this method to elicit learners' prior knowledge of the previous lesson through a real-life context.

- *Interaction with New Knowledge*

  After eliciting learners' prior knowledge through the simulation video, the teacher displayed the Word document again, reflecting the second section. The second section was divided into two parts: Part One focused on the advance information relating to the topic of levers and Part Two on the advance information relating to topic of gears. Part One encompassed notes on the advance information concerning levers and exercises related to this topic. Part Two encompassed notes on the advance information concerning gears and exercises related to this topic.

  In Part One, the teacher explained the concept of levers and showed the learners how to calculate the mechanical advantage of levers by considering the effort load and applied force. After the explanation, the teacher carried out three class exercises with the learners as indicated below.

  The first exercise demonstrated to the learners how the mechanical advantage is calculated:

  Exercise 1: *Calculate the mechanical advantage for a load of 40 N when the required force to lift the load is 15 N*

  Data

  MA =?

  L = 40 N

  E = 15 N

  Calculation

  MA = L/E

  = 40 N / 15 N

  = 2.7

The teacher emphasised that since the mechanical advantage is a ratio of two of the same quantities, it does not have a unit. It is simply a constant for the given system.

The following exercises were given to the learners for them to complete:

Exercise 2: *A force of 35 N is applied to a machine with a mechanical advantage of 0.75. What is the size of the load this machine can lift?*

Exercise 3: What is the effort required to lift a load of 500 N, with a mechanical advantage of 1.6?

After the exercise on levers, the teacher introduced Part Two of the advance knowledge of gears. He projected the document again that reflected the notes explaining the advance knowledge of gears, including the concepts of gear ratio, gear speed/rotation and efficiency, and their relationship with the number of teeth on a gear when calculating mechanical advantage. In addition, an exercise covering the calculation of mechanical advantage/number of teeth on the driver gear or driven gear was provided. In the second section, the teacher explained concepts of gears and showed learners how to calculate the mechanical advantage of gears taking into consideration gear ratio (teeth on the driver gear and driven gear) and efficiency. After the explanation, he provided three class exercises for the learners to address. In the first exercise, the teacher showed the learners how to calculate mechanical advantage:

Exercise 1: *What is the mechanical advantage (MA) if the efficiency is 93.5% and the VR is 4?*

Data

MA?

η = 93.5%

VR = 4

Calculation

MA = (η×VR)/100

= (93.5×4)/100

= 3.74

The following two exercises were given to the learners to complete on their own:

Exercise 2: *Calculate the efficiency when the mechanical advantage is 2.5 and the VR is 4.*

Exercise 3: *Calculate the gear ratio when the mechanical advantage is 1.3 and the efficiency is 72.22%.*

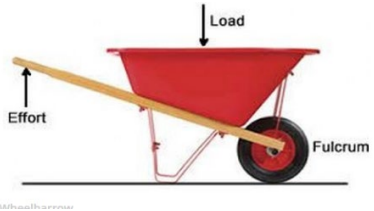
As the learners were completing the exercises regarding both levers and gears, the teacher was walking around to check how the learners were progressing. He saw that some groups responded correctly, and some groups responded incorrectly. Informed by his observations and interactions with the learners as he was moving around, the teacher provided explanations/clarity after the exercises were completed, referring to the Word document in some instances. The teacher used this approach to help the learners to engage and acquire new knowledge. Upon concluding the exercises on gears with the learners, the teacher gave them an activity to understand how they could construct their own knowledge.

- *Construction of Own Knowledge*

The last section of the document contained an activity that the learners were required to complete immediately after the lesson presentation.

Activity

1. A wheelbarrow has to lift dirt off the ground in order to transport it, the length from the fulcrum to the load is is $8.101m$, the distance from the end of the fulcrum to the lever is $8.755m$. What is the quantity for the value of mechanical advantage generated by the lever.



2. *You are riding a bicycle to see your friend. Your bicycle has two gears. The driver gear has 50 teeth, and the driven gear has 25 teeth. Calculate the mechanical advantage.*

Although the activity was supposed to be completed in class, because of time constraints, the teacher requested the learners to complete the activity at home.

The teacher used this approach to help the learners engage, to make meaning, and to draw their conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The first lesson was good. Using Educational Technologies, the teacher was able to engage the learners actively. The teacher succeeded in eliciting prior knowledge and engaging the learners in their acquisition of knowledge about the topics of interests. However, the teacher did not fully exploit the affordances of Educational Technologies during the presentation. Moreover, the learners were not afforded the opportunity to harmonise what they knew before coming to class and what they had acquired during the lesson, allowing them to take charge and ownership of the new information. Moreover, having two subtopics to present in one lesson was too much to process for the learners, leaving room for improvement in the presentation of the second lesson.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentations of the first lesson. During the observations, the researcher had noted that a few areas needed improvement. To better the lesson presentation, the researcher noted the aspects of topic and use of Educational Technologies. On the issue of topic, the researcher and the teachers agreed that for better focus, the teacher must make a presentation focusing on one topic. Therefore, the topic was to be trimmed to only levers instead of trying to fuse two topics into one presentation (gears and levers). On the use of Educational Technologies, they also agreed that the teacher should design and use a PowerPoint presentation slide and a YouTube video instead of using simulation videos and a Word document.

C. Second cycle of classroom observation

The same class setup, the laptop and the whiteboard, was employed to display the PowerPoint presentation slides, the simulations, and the YouTube videos and to provide flexibility and creativity in the presentation and enhance the comprehension of knowledge. Therefore, the topic was trimmed to only levers and the PowerPoint presentation slides were designed and aligned with the simulations and the YouTube videos as suggested during the reflection session:

- *Interaction with Prior Knowledge*

As he entered the classroom, the teacher greeted the learners. He then connected his laptop with a projector to enable the projection of his lesson presentation on the whiteboard. After completing the connection, the teacher wasted no time in displaying the PowerPoint slides. The slides had three sections, as did the lesson presentation: a section for prior knowledge, a section for new knowledge, and a section for construction of knowledge. The first section of the slides consisted of bulleted lists outlining the lesson and the lesson objectives (i.e., what the lesson was all about and what was to be achieved by the end of the lesson). The PowerPoint slides also contained text relating to the concept of a lever and 3D pictures of mechanisms that can be seen in different classes of levers. The second section involved notes introducing the advance knowledge of levers, and the third section incorporated an activity that covered the topic of levers.

Thereafter, the teacher displayed the PowerPoint slides and as part of the introduction to the lesson, he explained the lesson, outlined the topic, and indicated the expectations and what was to be achieved by the end of the lesson, clearly stating the lesson objectives. After the introduction, the teacher moved to the other slides. He engaged the learners through the question-and-answer method in which the learners were required to define concepts relating to levers such as effort, force, applied force, and fulcrum/pivot and displayed slides with 3D pictures of tools such as the wheelbarrow, hammer, and stapler. The teacher asked the learners to identify the positions of load, fulcrum, and effect and to categorise them into their respective classes of levers (first class, second class, and third class). This was part of recapping on the previous lesson, which enabled the teacher to extract additional previous knowledge about levers and make sure that the learners were actively participating in their learning. The teacher used this approach to elicit learners' prior knowledge from the previous lesson through a real-life context about levers.

- *Interaction with New Knowledge*

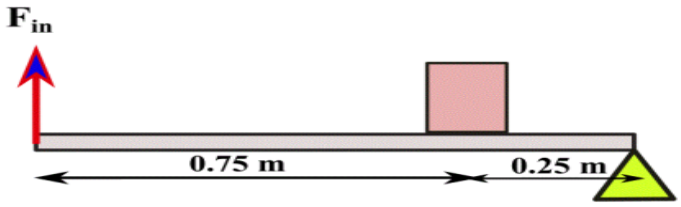
  After eliciting learners' prior knowledge through the PowerPoint presentation of slides, the teacher displayed the PowerPoint slides that reflected the second section. These slides had notes focusing on the following concepts of the advance topic of levers: effort, load, applied force, and mechanical advantage. The slides

also had well-summarised notes explaining the relationships between the concepts of levers (i.e., effort force/arm/distance, load force/arm/distance, and mechanical advantage). On the same set of slides, the teacher demonstrated a detailed approach to how mechanical advantage can be calculated using formulae and displayed the SI units involved in the calculation. In addition, a classroom exercise covering the topic of levers and calculating mechanical advantage was included.

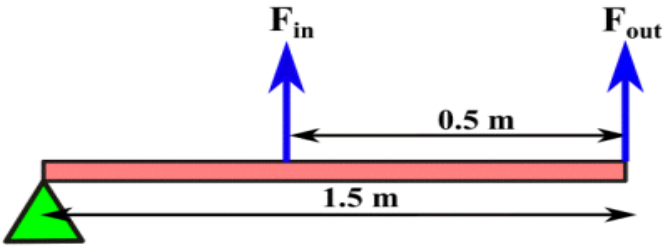
Using the displayed set of PowerPoint slides, the teacher provided explanations for the learners regarding the relationships between effort force, applied force/force load, and mechanical advantage. He explained step-by-step how to calculate mechanical advantage, effort force/arm/distance, and load force/arm/distance. Thereafter, he played a five-minute YouTube video, complementing the information that was disseminated through the PowerPoint slides and unpacking the formula to calculate mechanical advantage, further showing the learners how to calculate mechanical advantage/effort force/load with examples. The video was played to the end without pausing or interrupting. After the YouTube video, the teacher once again displayed the PowerPoint slides for the second section, presenting the exercises indicated below for calculating the mechanical advantage/effort force/ effort load in levers. The learners were to complete these exercises in their respective groups.

Exercise 1: *Calculate the mechanical advantage of a lever in which the effort arm is 50 cm, and the load arm is 2 cm.*

Exercise 2: *The following illustration shows a 1 m long horizontal bar supported on the fulcrum. Calculate its mechanical advantage. What class of lever is this?*



Exercise 3: *Select the appropriate option showing the class of lever and the mechanical advantage of the lever that is presented in the figure below.*



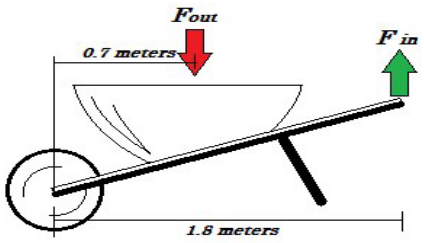
As the learners were completing the exercises, the teacher was walking around checking how the learners were progressing and providing guidance if necessary. The teacher used this approach to help the learners to engage and acquire new knowledge:

- *Construction of Own Knowledge*

  After the exercises on levers had been concluded with the learners, the teacher played the YouTube video again, unpacking how mechanical advantage is calculated and demonstrating with a few examples. Thereafter the teacher displayed the PowerPoint slides, reflecting the last section. The PowerPoints slides presented an activity for the learners to complete in their respective groups immediately after the lesson presentation.

  Group Activity

  1. *A wheelbarrow is used to lift dirt off the ground before transporting it. The length from the fulcrum to the load is 0.7 m and the distance from the fulcrum to the handles is 1.8 m, as shown below.*



     i. *What is the type of lever in the picture above?*
     ii. *What is the value of the mechanical advantage that is generated?*

  2. *A worker uses a long plank and a round log to move a heavy rock out of the way. The worker exerts a force of 355 N on the plank.*

     i. *If the part of the plank between the worker and the log is 2.8 m in length and the part between the log and the rock is 30 cm, calculate the*

mechanical advantage of the lever.

ii. *Calculate the maximum mass of rock that he could move with the lever.*

3. *A broom is held by a worker while sweeping in such a way that the distance between the floor and the worker's lower hand is 1.05 m.*

   i. *What class of lever is the tool used by the worker?*
   ii. *If the mechanical advantage of the broom lever is 0.3 m, calculate the distance between the worker's two hands.*

Unlike the exercises performed earlier, it is clearly noted that the activity used scenarios instead of straightforward questions/statements. Therefore, in completing the activity, learners were expected to analyse the information at their disposal to complete the activity. As the learners were completing the activity, the teacher (as a facilitator) assisted them in their respective groups through Socratic questioning. While conducting the activity, the learners were active in their learning, interacting, and collaborating with one another in their respective groups. After completion of the activity, the learners were required to present their responses. This process allowed the learners from different groups to critique the responses, thus enabling more clarity and understanding regarding the types of levers, how they operate, and the calculations involving the mechanical advantage of the levers. The teacher used this approach to help the learners engage, make meaning, and draw their conclusions. In building their knowledge, their prior knowledge and new knowledge were harmonised in a real-life context.

- *The use of Educational Technologies to present creative lessons*

The second lesson exceeded the first lesson because the teacher showed a significant improvement in the use of Educational Technologies, resulting in a better presentation of the lesson. Using Educational Technologies, the teacher managed to present the information in multiple ways, resulting in better comprehension. Moreover, he also manged to keep the class interactive by actively engaging the learners. As such, the teacher succeeded in eliciting prior knowledge, in engaging the learners in their acquisition of knowledge, and in creating a platform where learners could discuss, critique, and debate their understanding of new concepts in relation to what they already knew and what had been recently learnt,

harmonising the new knowledge with their own understanding of the topic by taking advantage of the affordances of Educational Technologies.

5.3.2.2 Jude classroom observation (School B)

The topic for the lesson presentation was based on Mechanical Systems and Control focusing on gears in a Grade 9 senior-phase Technology classroom. The Educational Technologies that were used in the lesson were a smartphone, a laptop, and a smartboard to display YouTube videos and PowerPoint slides during the presentation.

A. First cycle of classroom observation

- *Interaction with Prior Knowledge*

The teacher greeted the learners as he entered the classroom and asked them, to be on their best behaviour for the duration of the lesson. The necessary connections were already in place, which saved time. The teacher started by displaying PowerPoint slides using his cell phone that was connected to the smartboard. The PowerPoint slides covered all three sections, IPK, INK, and COK. In the first section the slides consisted of bulleted lists outlining the topic of the day and the lesson objectives for the introduction of the lesson. As before, the slides contained well-summarised notes about gears, recapping on what was covered in the previous grade about gears. The second section of the slides offered the advance content regarding gears. In addition, the slides had an exercise for the learners to do. The third section of slides presented an activity for the learners to complete immediately after the lesson presentation.

Using the first section of the slides, the teacher took the learners through the lesson of the day, starting with an introduction of the topic (gears). As part of the instruction, he also took the learners through the lesson objectives as outlined in the slides. After the introduction, the teacher moved to the next slides that presented a summary of what was done in the previous grade regarding the topic of gears. Through the question-and-answer method, the teacher engaged the learners as a way of recapping and extracting the learners' knowledge of gears. The teacher used this approach to elicit learners' prior knowledge from a previous lesson and their experiences of gears.

- *Interaction with New Knowledge*

After eliciting learners' prior knowledge through PowerPoint, the teacher again displayed the PowerPoint slides that reflected the second section. This set of slides contained the advance knowledge of gears, including a list of the different types of gears, a summary providing explicit descriptions/explanations of each the type of gear, 3D pictures of the different types of gears and their uses, and an outline of their advantages and disadvantages.

Using the PowerPoint, slides the teacher took the learners through the summary, explaining the important concepts of gears. Furthermore, while showing them the different types of gears using the 3D pictures, the teacher questioned the learners and initiated a whole-class discussion to complement the information presented using slides, the teacher displayed a YouTube video about the different types of gears (i.e., spur gear, bevel gear, rack pinion gear, and worm gear). The projected YouTube videos showed 3D views of the range of gears and their uses. The teacher continually played and paused the video, trying to emphasise certain aspects that were presented in the video. Also shown in the video were mechanisms that use different types of gears to operate or perform their designated tasks. These mechanisms included a watch, gate motor, tin opener, washing machine, flour mixer, bicycle, and manual hand drill. The display provided better visualisation of the gears, increasing learners' comprehension of gears. At the end of the video, the learners were required to complete the exercise, which is presented below:

Exercise:

In your respective groups, identify at least two different mechanisms that were shown in the video you watched and state the type of gear that each mechanism is using to operate.

As the learners were completing the exercise, the teacher walked around and checked how they were progressing. If a group was experiencing challenges, he asked them questions that helped them to complete the exercise. The teacher used this approach to help learners to engage and acquire new knowledge about gears in a real-life context.

- *Construction of Own Knowledge*

Once the teacher had concluded the exercises on gears with the learners, he displayed the PowerPoint slides reflecting the third section. The slides had an activity for learners to complete, which is shown below.

Activity:

Gears have proved to be important in our daily lives, as they are used across all fields. In your respective groups and guided by the categories below, identify a tool/mechanism that uses a gear to operate or perform a specific task and indicate the type of gear it uses:

a. *Household*
b. *Construction*
c. *Health*

As the learners were completing the activity, the teacher was moving around and helping the learners to complete the activity. Though Socratic questioning, dialogue was created, enabling the learners to debate, discuss and, critique each other's views and ultimately, agree on the answers or discoveries. Sharing their answers with the rest of the class formed part of the activity; however, because of the lack of time, this was not possible. The teacher, therefore, indicated that this would be done in the next class. The teacher used this approach to help learners engage, make meaning, and draw their conclusions, building their knowledge about gears in a real-life context.

- *The use of Educational Technologies to present creative lessons*

The first lesson presentation was good. The teacher used a smartphone and a laptop to display PowerPoint slides and YouTube videos, thus actively engaging the learners. Moreover, the information was presented in multiple ways to enhance the comprehension of knowledge. The teacher succeeded in eliciting prior knowledge on the topics of interest and helping learners to engage in new information by taking advantage of the affordances of Educational Technologies. However, this was only achieved to a limited extent. For instance, the question-and-answer method adopted by the teacher was unstructured, compromising coherence and logic and bringing about confusion in the learners. In addition, failure to complete the activity as planned deprived the learners of opportunities to dissect information, make meaning, and clarify any misconceptions that they may have had about gears.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher had a session to reflect on the presentation of the first lesson. During the observations, the researcher had noted a few areas that needed improvement to better the presentation of the lesson. The researcher noted inconsistencies in the question for the extraction of prior knowledge. The researcher and the teacher agreed that the teacher needed to restructure the question for better coherence, thus guiding the manner in which the knowledge is consumed by the learners. Again, the researcher noted that during the presentation, the teacher continually played and paused the YouTube video. The researcher and the teacher agreed that the teacher needed to play the video at least twice to the end without interruption, which would allow the learners to digest the information presented to them.

C. Second cycle

The same class setup (the smartphone, laptop, smartboard to display YouTube videos and PowerPoint slides) was used for better comprehension and to provide flexibility and creativity in the presentation. However, the questioning strategy was addressed since it was an issue of concern during the reflection session.

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as he entered the classroom. The necessary connections were already in place given that it was a smart class, which saved time. The teacher started by displaying the PowerPoint slides using his cell phone, which was connected to the smartboard. The PowerPoint slides covered all three sections: IPK, INK, and COK. In the first section, the slides for the introduction to the lesson had bulleted lists outlining the topic of the day and the lesson objectives. Again, contained in the slides were well-summarised notes about gears, recapping on what had been covered in the previous grade in relation to gears. The second section of the slides presented the advance content of gears. In addition, the slides had an exercise for learners to do. In the third section of slides, there was an activity for the learners to complete immediately after the lesson presentation.

  Using the displayed PowerPoint slides that reflected the first section, the teacher took the learners through the lesson of the day, starting with the introduction of the topic, which was gears, and the lesson objectives. After the introduction, the teacher moved to the next slides that had a summary of points of what was covered

in the previous grade concerning gears. Through the question-and-answer method, the teacher engaged the learners as a way of recapping and extracting the learners' knowledge on gears. In doing so, his questioning was more structured, thus bringing logic and cohesion in the way that the information was handled. The teacher used this approach to elicit the learners' prior knowledge of gears from the previous grade in a real-life context.

- *Interaction with New Knowledge*

  After eliciting learners' prior knowledge through PowerPoint, the teacher again displayed the PowerPoint slides reflecting the second section. These PowerPoint slides contained the advance content/information on gears for Grade 9. The slides presented a list of the different types of gears and a well-detailed summary that provided explicit descriptions/explanation of each type of gear. In addition, 3D pictures of the different types of gears indicating their uses and their advantages and disadvantages were presented.

  Using the PowerPoint slides, the teacher took the learners through unpacking the advance content of gears, tracking themes and explaining and providing descriptions of the different types of gears. The descriptions were accompanied by 3D pictures of each type of gear, enhancing the visualisation and the understanding of gears. Furthermore, through questioning, the teacher initiated a whole-class discussion to engage the learners further with the new information. To complement the information that was presented using slides, the teacher displayed a YouTube video about the different types of gears (i.e., spur gear, bevel gear, rack pinion gear, worm gear). The projected YouTube videos provided 3D views of the range of gears and their uses. The teacher played the YouTube video twice to the end without pausing or interrupting to allow the learners to grasp and digest the information being presented. Also shown in the video were mechanisms that use different types of gears such as the watch, gate motor, tin opener, washing machine, flour mixer, bicycle, and manual hand drill. The display provided a better visualisation of the gears, which increased the learner's comprehension of gears. At the end of the video, the learners were required to complete the exercise shown below.

Exercise:

In your respective groups, identify at least two different mechanisms that were shown in the video and state the type of gear that the mechanisms use to operate.

As the learners were completing the exercise, the teacher walked around and checked how the learners were progressing. If a group was experiencing challenges in completing the exercise, he asked them questions that helped them to complete the exercise. This was the approach used by the teacher to engage learners in the new knowledge about gears.

- *Construction of Own Knowledge*

Once the teacher had concluded the exercises with the learners on gears, he displayed the PowerPoint slides again, reflecting the third section. The slides presented an activity with instructions for the learners to complete.

Activity:

Gears have proved to be important in our daily lives, as they are used across all fields. In your respective groups and guided by the categories below, identify a tool/mechanism that uses a gear to operate or perform a specific task and indicate the type of gear it uses:

a. *Household*
b. *Construction*
c. *Health*

During the completion of the activity, the teacher, as a facilitator, was moving around and checking how the learners were progressing in their respective groups. Through Socratic questioning, he assisted the learners in completing the activity. The creation of Socratic dialogue promoted discussion and debate, and through interaction and collaboration, made the learners take charge of their learning. After completion of the activity, the learners presented their findings/responses, providing further clarification of questions that arose from their peers in the other groups. The teacher used this approach to help the learners engage, make meaning, and draw their conclusions, thus building their knowledge about gears in a real-life context.

- *The use of Educational Technologies to present creative lessons*

  The second presentation of the lesson was good. A smartphone, laptop, and smartboard to project the PowerPoint slides and the YouTube videos were used by the teacher to extract the learners' prior knowledge about gears, to provide the learners with a platform to digest new information, and to afford the learners with opportunities to harmonise what they knew and what they had learnt and thus take ownership of their knowledge building. In the second presentation, there was logic and coherence in the manner that the questions were asked. For better comprehension of the information, the teacher managed to use the technologies to present the information in multiple ways. Moreover, he manged to keep the class interactive by actively engaging the learners. He achieved all these by exploiting the affordances of the technologies such as repeating, rewinding, and pausing a YouTube video when needed.

5.3.2.3 Judith classroom observation (School C)

The lesson presentation was based on Electrical Systems and Control focusing on resistance in a Grade 9 senior-phase Technology classroom. Educational Technologies used in the lesson were a laptop and a whiteboard to project YouTube videos and PowerPoint slides during the presentation.

A. First cycle of classroom observation

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as she entered the class. With help from an assistant teacher, she connected the laptop to a projector and tested if it was working for her PowerPoint presentation on the whiteboard. The PowerPoint slides had two sections: IPK and INK. The slides for the first section had a bulleted list of points about electrical components and their roles, recapping on the previous lesson. The slides for the second section had notes about the advance content of electricity focusing on resistance. In addition, the slides had an exercise for the learners to do.

  Despite the availability of a laptop connected to a projector to project her lesson presentation, the teacher verbally took the learners through the lesson of the day, starting with an introduction to the topic of resistance. Furthermore, as part of the introduction, she outlined the lesson objectives. After the introduction, using the

displayed PowerPoint slides, the teacher engaged the learners through the question-and-answer method, recapping and extracting what the learners knew about electricity. She used this approach to elicit the learners' prior knowledge of electricity from a previous lesson in a real-life context.

- *Interaction with New Knowledge*

  After eliciting the learners' prior knowledge through PowerPoint, the teacher displayed the PowerPoint slides that reflected the second section. This set of slides contained the advance content for determining resistance such as a table of colour codes and a 3D picture of a giant resistor, visibly showing all the colour bands (1st band, 2nd band, 3rd band and the tolerance) on the resistor.

  Using the PowerPoint slides, the teacher took the learners through the colour code table, explaining the meaning of each band to enable them to read the colour codes in relation to the table and demonstrating the approach for how to determine the resistance of a resistor using the colour code table. To complement the information presented using slides, the teacher then displayed a YouTube video. The video unpacked the approach for how to determine resistance using the table code and the colour bands on a resistor. The teacher played and paused the video continually, posing questions, taking questions, or further clarifying the new information presented in the video. The display provided a better visualisation of the resistors for the learners, enabling better comprehension relating to the determination of resistance. At the end of the video, the learners were required to complete the exercises shown below.

  The teacher did the first exercise with the learners.

  Exercise 1: *Find the value of a carbon resistor with the colour bands orange, blue, brown, and gold.*

  Solution:

  As we know, the first two colours depict significant digits of the resistance, the third colour is the multiplier, and the last colour band is the tolerance value. As seen from the colour code table,

  Orange colour code is 3

  Blue colour code is 6

  Brown colour code is 10^1

  And gold colour code is ±5%±5%

Therefore, the value of the resistor is 360±5%

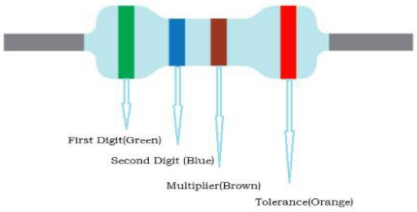
The teacher then instructed the learners to complete the remaining exercises:

Exercise 2: *What is the nominal resistance of a resistor with colour code brown-green-black-silver?*

Exercise 3: *What is the colour code for a 4.7 kΩ resistor with 5% tolerance?*

Exercise 4: *A 1000 Ω resistor has a four-band colour code following a colour sequence of brown, black, red, and gold. The 1000 Ω resistor has a multiplying factor of 100 (red) and a tolerance level of ±5% (gold). What is the resistor colour code for a 1000 Ω resistor?*

Exercise 5: Example 4. *Determine the nominal resistance and tolerance for the resistor shown below.*



As the learners were completing the exercises, the teacher walked around and checked how the learners were progressing. She guided the groups that were experiencing challenges in completing the exercise with guiding questions. This was the approach used by the teacher to engage the learners in acquiring new knowledge about resistance.

- *Construction of Own Knowledge*

After the teacher had concluded the exercises with the learners on resistance, she displayed a Word document with an activity for the learners to complete in pairs:

Activity

1.1 When a resistor conducts electric current, its temperature increases. Explain how this phenomenon is significant in the application of resistors in electric circuits.

A. In other words, why would we care about a resistor's temperature increasing?

B. What does this indicate about the technical ratings of resistors?

C. *Aside from having a specific resistance rating (i.e., a certain number of ohms), what other rating is important for the proper selection of resistors in electric circuits?*

1.2 *Calculate the resistance, minimum resistance, and maximum resistance of this resistor.*

a. *Minimum resistance*

b. *Maximum resistance*

As the learners were completing the activity, the teacher moved around and helped the learners to complete the activity. Through Socratic questioning, dialogue was created, enabling learners to debate, discuss, and critique each other's views and ultimately, agree on the answers or discoveries. After completion of the activity, the teacher randomly chose learners to write their answers on the board. Thereafter, she went through each response, asking if it was correct and if not, requesting them to come to the board and rectify the response. The teacher used this approach to help the learners to engage, to make meaning, and to draw their conclusions, thus building their knowledge on resistance.

- *The use of Educational Technologies to present creative lessons*

The first lesson was good because through the use of Educational Technologies, the teacher was able to engage the learners actively. The teacher succeeded in extracting what the learners already knew and in engaging the learners in their acquisition of knowledge on the topic of resistors and resistance. However, the teacher did not fully exploit the affordances of the Educational Technologies during the presentation, leaving room for improvement in the second lesson presentation.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentation of the first lesson. During the observations, the researcher had noted a few areas that needed improvement to better the lesson presentation. The researcher noted the inconsistencies in the questions that brought about the play and pause of the video. The researcher and the teacher agreed that the teacher needed

to play the video to the end and to play it more than once to allow the learners to digest the information. Again, the researcher and the teacher agreed that the teacher should also use simulation to complement the presentation of the PowerPoint slides for better comprehension of the new information. For the introduction and the activity, the teacher needed to design PowerPoints slides for better visualisation since the resistors use colour band to determine the resistance of a resistor.

C. Second cycle of classroom observation

The same class setup was observed. The laptop, projector, and whiteboard were used to display information, and the PowerPoint slides provided flexibility and creativity in the presentation and better comprehension of the information. The playing of the video more than once and to the end, an issue of concern during the reflection session, was implemented.

- *Interaction with Prior Knowledge*

The teacher greeted the learners as she entered the class. With the help of an assistant teacher, the laptop was connected to a projector and was tested to ensure that it was working. For her presentation, the teacher displayed her PowerPoint presentation on the whiteboard. The PowerPoint slides comprised three sections: IPK, INK, and COK. The slides for first section exhibited a bulleted list of points in the form of questions about electrical components and their roles, recapping on the previous lesson. The slides for the second section contained notes about the advance content of electricity, focusing on resistance. The slides also included an exercise for the learners to do. The third section of the PowerPoint slides presented an activity for the learners to complete immediately after the lesson presentation.

Using the first slide, the teacher took learners through the lesson of the day, starting with an introduction to the topic, resistance in electric circuits. As part of the instruction, she also explained the lesson objectives as outlined in the slides. After completing the introduction, the teacher moved on to the next slides. These included a set of questions recapping on what was done during the previous lesson such as ‘What is the importance of electricity in our daily lives?’ and other statements such as ‘Name some electrical components and indicate their uses’. Through the question-and-answer method, the teacher engaged the learners as a way of recapping and extracting what the learners knew about electricity. The

teacher used this approach to elicit the learners' prior knowledge of electricity in a real-life context from a previous lesson.

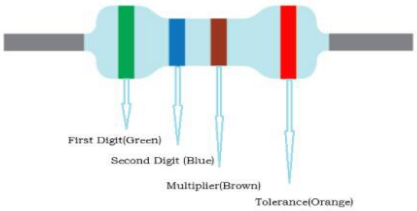
- *Interaction with New Knowledge*

After eliciting learners' prior knowledge through PowerPoint, the teacher again displayed the PowerPoint slides that reflected the second section. The slides contained the advance content of resistance. Summarised notes explained the concepts and the table of colour codes, with a 3D picture of a giant resistor visibly showing all the colour bands (1st band, 2nd band, 3rd band) and the tolerance on them. The slides also indicated a step-by-step approach of how to determine resistance. In addition, the slides included an exercise for the learners to complete.

Using the PowerPoint slides, the teacher took the learners through the notes, explaining the relationships of concepts and how resistors work in providing resistance. In her explanations, she used examples of household electrical appliances such as the iron, hair dryer, heater, and two-plate stove. She then switched and displayed a simulation video. The simulation video demonstrated how a resistor works in different appliances, using the concept of a water reticulation system in which different sizes of valves represent different sizes of resistors. Thereafter, the teacher took the learners through the colour code table, explaining the meaning of each band so that the learners were able to read the colour codes in relation to the table. She also guided them through the step-by-step approach to determining the resistance of a resistor using the colour code table. To complement the information that was presented using slides, the teacher displayed a YouTube video on how to determine resistance, and this was played to the end without pauses or interruptions. Following this, the teacher responded to questions seeking clarity regarding the information presentation. The display provided better visualisation of the resistors and the colour code table, resulting in better comprehension of resistance. At the end of the video, the learners were required to complete the exercises that are shown below:

> ***Exercise 1****: What is the colour code for a 4.7 kΩ resistor with 5% tolerance?*
>
> ***Exercise 2:*** *A 1000 Ω resistor has a four-band colour code following the colour sequence of brown, black, red, and gold. The 1000 Ω resistor has a multiplying factor of 100 (red) and a tolerance level of ±5% (gold). What is the resistor colour code for a 1000 Ω resistor?*

***Exercise 3: Example 4**. Determine the nominal resistance and tolerance for the resistor shown below.*



As the learners were completing the exercises, the teacher walked around and checked how the learners were progressing. She assisted the groups that were experiencing challenges in completing the exercise through guiding questions. This was the approach used by the teacher to engage learners in their acquisition of new knowledge on resistance in a real-life context.

- *Construction of Own Knowledge*

After the teacher had concluded the exercises with the learners on resistance, she displayed a YouTube video and instructed the learners to watch carefully so that they could complete the activity at the end of the video. The video was played twice and to the end to allow the learners to digest the information that was presented in the video. The teacher then displayed a PowerPoint slide that reflected the third section. The slide introduced the activity that was to be completed by the learners in groups:

Activity

1.1 When a resistor conducts electric current, its temperature increases. Explain how this phenomenon is significant in the application of resistors in electric circuits.

a. In other words, why would we care about a resistor's temperature increasing?

b. What does this indicate about the technical ratings of resistors?

c. Aside from having a specific resistance rating (i.e., a certain number of ohms), what other rating is important for the proper selection of resistors in electric circuits?

1.2 Calculate the resistance, minimum resistance, and maximum resistance of this resistor.

a. *Minimum resistance*
b. *Maximum resistance*

As the learners were completing the activity, the teacher moved around and helped the learners to complete the activity using Socratic questioning, thus creating a dialogue that enabled learners to debate, discuss, and critique each other's views and ultimately agree on the answers or discoveries. After completion, the teacher randomly chose learners to go to the board and write their answers. Thereafter, she went through each response, asking if it was correct and if not, requesting the learners to correct it. The teacher used this approach to help the learners to engage, to make meaning, and to draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The second lesson was considerably better than the first because there was significant improvement in the teacher's use of Educational Technologies, resulting in a better presentation of the lesson. Using a laptop connected to a projector, the teacher managed to present the information in multiple ways (PowerPoint, simulation, and YouTube) for better comprehension. Moreover, she manged to keep the class interactive by actively engaging the learners. As such, the teacher succeeded in eliciting prior knowledge, in engaging the learners in new information, and in providing the learners with opportunities to redefine, discover, and make meaning of the world in their own way.

5.3.2.4 Calton classroom observation (School D)

The topic for the lesson presentation was based on Electrical Systems and Control focusing on the application of Ohm's Law in a Grade 9 senior-phase Technology classroom. The Educational Technologies used in the lesson presentation was a laptop connected to a projector to display PowerPoint slides, a YouTube video, and simulations of electricity on the whiteboard.

A. First cycle of classroom observation

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as he entered the classroom. The necessary connections had already been made by the assistant teacher; a laptop had been connected to a projector for displaying the information. The teacher opted to use a hard copy for reference during the presentation. The document contained notes explaining concepts about electricity, recapping on the previous lesson.

  Despite the availability of a laptop connected to a projector to display his presentation, the teacher referred to the hard copy document and verbally explained the lesson of the day to the learners, introducing the topic of electricity with a focus on resistance. Furthermore, as part of the introduction, the teacher briefly outlined the lesson objectives. After the introduction and once again referring to the hard copy document, the teacher engaged the learners through the question-and-answer method, recapping and extracting the learners' prior knowledge on electricity from the previous lesson. The questioning was based on voltage, current, and resistance, extracting what the learners knew about important concepts of electricity and laying the foundation to introduce Ohm's Law. The teacher used this approach to elicit the learners' prior knowledge on electricity from the previous lesson.

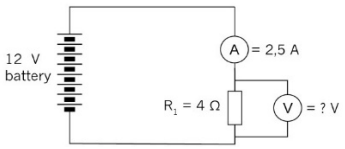
- *Interaction with New Knowledge*

  After eliciting the learners' prior knowledge using the hard copy document, the teacher displayed a YouTube video focusing on voltage, current, and resistance for the learners. After the video, he displayed a Word document that contained notes explaining/describing the relationship between current, voltage, and resistance in relation to Ohm's Law. The document contained a step-by-step outline on how to use Ohm's Law in problem-solving. Additionally, the document had classroom exercises covering the calculation of current, voltage, and resistance by applying Ohm's Law. Lastly, the document presented an activity for learners to complete immediately after the lesson presentation.

  The teacher played and paused the video continually and engaged the learners through the question-and-answer method. The YouTube video unpacked Ohm's Law, and the question-and-answer method was aimed at introducing and guiding the learners to understand the relationship between current, voltage and resistance

in relation to Ohm's Law. To complement the YouTube video clip, the teacher displayed the Word document on the whiteboard, continuing to unpack Ohm's Law and explain and clarify the relationship between current, voltage, and resistance so that the learners could state Ohm's Law in context with understanding and apply it to problem-solving. After these explanations, the teacher presented the following class exercises to the learners. He conducted the first exercise with the learners to show them how to use Ohm's Law in their calculations:

Exercise 1: *Calculate the value of the voltage supply in the circuit below if the resistor has a value of 4 Ω and the current through the resistor is 2.5 A.*



<u>Data</u>

V =?

I = 2.5 A

R = 4 Ω

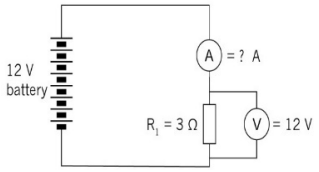
V = I×R

=2.5 A × 4 Ω

=10 V

The remaining exercises were given to the learners to complete:

Exercise 2: *Use the diagram below to determine the current flow in the circuit.*



Exercise 3: *A 9 V battery maintains a current of 3 A through a radio. What is the resistance in the circuit?*

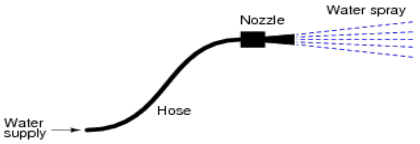
As the learners were completing the exercise, the teacher walked around checking how the learners were progressing and helping the learners to complete the exercise through posing guiding questions. The teacher used this approach to help the learners to engage and acquire new knowledge.

- *Construction of Own Knowledge*

After the teacher had concluded the exercises with the learners on the application of Ohm's Law, he distributed hard copy documents with an activity for the learners to complete:

Activity

1.1 For a given amount of water pressure, which will result in a greater water flow rate: a small (restrictive) nozzle or a large (unrestrictive) nozzle? Explain how this relates to the study of voltage, current, and resistance in a simple electric circuit.



1.2 In building the circuit below and taking measurements of the current through the resistor and the voltage across the resistor, the results seen in the Table of Results were obtained. Using the results in the table, plot the graph of Voltage v/s Current on the graph paper that is provided.

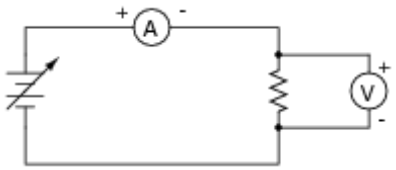
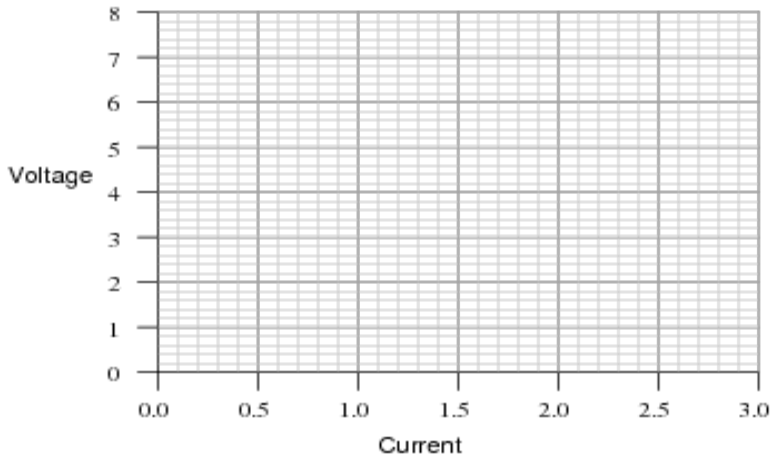


Table of Results

Voltage (V)	*Current (A)*	*Resistance (Ω)*
0.22	*0.66*	*6*
0.47	*1.42*	*6*
0.85	*2.54*	*6*
1.05	*3.16*	*6*
1.50	*4.51*	*6*
1.80	*5.51*	*6*
2.00	*5.99*	*6*
2.51	*7.49*	*6*



1.3 Which mathematical relationship do you see between voltage and current in this simple circuit?

1.4 Use the graph to draw conclusions about the relationship between voltage, current, and resistance.

However, the activity was not completed since the electricity was cut off because of loadshedding, and the teacher, therefore, instructed the learners to complete the exercise at home as homework. The teacher used this approach to help learners to engage, make meaning, and draw their conclusions, thus building their knowledge on electricity in a real-life context.

The first lesson presentation was good. Using a laptop connected to a projector to display the YouTube videos and the Word document, the teacher was able to engage the learners actively. He succeeded in eliciting the learners' prior knowledge on electricity and helped the learners to digest and acquire new knowledge. However, the teacher did not fully exploit the affordances of Educational Technologies during the presentation. Therefore, he failed to provide the learners with opportunities to discover and make meaning of the world in their own way, leaving room for improvement in the presentation of the second lesson.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentation of the first lesson. During the observations, the researcher had noted a few areas that needed improvement, including the use of Educational Technologies. The researcher and the teacher agreed that the teacher should design

PowerPoint slides for a proper introduction to the lesson. The slides would also complement the YouTube videos that he would use throughout the lesson and display the activity instructions and the questions after the YouTube videos. Again, the YouTube videos were to be played at least twice and to the end before the questions and answers that solicited information, guided, and provided clarity. Lastly, the teacher agreed that for better comprehension and to help the learners to digest the newly acquired information, the teacher would use simulation videos to validate Ohm's Law.

C. Second cycle of classroom observation

The same class setup was used: the laptop and whiteboard to display the PowerPoint presentation slides and the YouTube videos to provide flexibility and creativity in the presentation and to aid in the comprehension of knowledge:

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as he entered the classroom. The equipment was already connected by the assistant teacher. The PowerPoint slides that the teacher displayed represented the three sections of the lesson presentation: the section for prior knowledge, the section for new knowledge, and the section for the construction of knowledge. The first section of the slides contained bulleted lists outlining the lesson objectives, what the lesson was all about, and what was to be achieved by the end of the lesson. The slides also included notes explaining the concepts of electricity, recapping on the previous lesson. The second section had notes introducing the advance knowledge of electricity in relation to Ohm's Law. The third section presented an activity covering Ohm's Law.

  To commence the presentation, the teacher displayed the PowerPoint slides that reflected the first section. The teacher briefly introduced the lesson, touching on the lesson's topic and the learning objectives. After the introduction, he moved to a slide that presented questions aimed at recapping on what had been covered in the previous lesson and determining the learners' knowledge on the topic. The teacher asked the questions and the learners answered based on their knowledge and understanding of what they knew about electricity. The questions were based on voltage, current, and resistance and were aimed at extracting what the learners knew about the important concepts of electricity, laying the foundation for introducing Ohm's Law. After concluding the question-and-answer method, the teacher displayed the first YouTube video, again recapping on the previous lesson

and providing clearer explanations of the concepts in relation to the slides that were projected earlier. The interchangeable use of PowerPoint slides and YouTube video clips made the lesson interactive, asking questions and providing clarity in tandem. The teacher used this approach to elicit the learners' prior knowledge on electricity from the previous lesson.

- *Interaction with New Knowledge*

After eliciting the learners' prior knowledge using PowerPoint slides and YouTube videos, the teacher displayed the PowerPoint slides reflecting the second section. The slides included notes focusing on the advance topic of electricity in relation to Ohm's Law. The notes were detailed and explained/described the relationship between current, voltage, and resistance in relation to Ohm's Law. The slides also presented a clear outline of the step-by-step approach to using Ohm's Law in problem-solving. Additionally, the slides introduced classroom exercises covering the calculation of current, voltage, and resistance by applying Ohm's Law.

Displaying the set of PowerPoint slides reflecting the second section, the teacher unpacked the relationship between current, voltage, and resistance as justified in Ohm's Law. He further explained step-by-step how to calculate current, voltage, and resistance by applying Ohm's Law. To complement the PowerPoint presentation slides, a second YouTube video was displayed on the whiteboard and played twice to the end without pauses or interruptions to enable the learners to digest and grasp the information presented to them. The video explicitly unpacked Ohm's Law and provided examples showing how it can be applied in problem-solving. After the video had been played, the teacher provided the learners with an exercise that consisted of two parts. The first part of the exercise involved the teacher performing a simulation and the learners observing and responding to a set of questions and drawing conclusions. The teacher displayed a simulation on the whiteboard that showed a circuit diagram with a connected bulb as the output, cell(s) as the input, and a voltmeter and ammeter to take readings of the voltage. The simulation helped the learners to process the newly acquired information further, validating Ohm's Law and ensuring that the learners actively participated in their learning. The teacher handed the learners the recording sheet and projected the simulation. As the teacher performed the simulations, the

learners were told to pay attention to the flow, the brightness of the bulb, and the readings of the voltmeter and ammeter and record what they observed. In performing the simulation, the teacher started with one cell, added a second cell, a third cell, and then a fourth cell.

Part 1

Exercise 1: *As the number of cells in the circuit are added, note the following:*

a. *What happens to the brightness of the bulb?*
b. *What is the reading on the voltmeter?*
c. *What is the reading on the ammeter?*

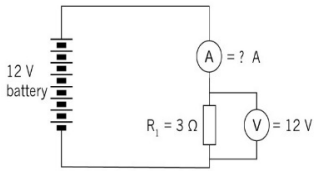
Lastly, the teacher allowed the learners to interpret and draw conclusions regarding their recordings, focusing on the readings of the voltmeter and the ammeter.

Bulb	Voltmeter	Ammeter

After completing the simulation exercise with the learners, the teacher provided the exercises that formed Part 2 for the learners to complete.

Part 2

Exercise 2: *Use the circuit in the diagram below to determine the current flow in the circuit.*



Exercise 3: *A 9 V battery maintains a current of 3 A through a radio. What is the resistance in the circuit?*

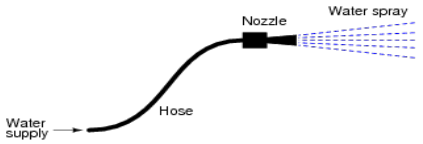
As the learners were completing the exercises, the teacher moved around, checking how the learners were progressing and helping them through guiding questions to complete the exercises. The teacher used this approach to help the learners to engage and acquire new knowledge.

- *Construction of Own knowledge*

After the teacher had concluded the exercises on circuits with the learners, he displayed a PowerPoint slide that reflected the third section. The slide presented an activity that was to be completed by the learners in their respective groups immediately after the lesson presentation.

Activity

1.1 For a given amount of water pressure, which will result in a greater water flow rate: a small (restrictive) nozzle or a large (unrestrictive) nozzle? Explain how this relates to the study of voltage, current, and resistance in a simple electric circuit.



1.2 In building the circuit below and taking measurements of the current through the resistor and the voltage across the resistor, the results seen in the Table of Results were obtained. Using the results in the table below, plot the graph of Voltage v/s Current on the graph paper that is provided.

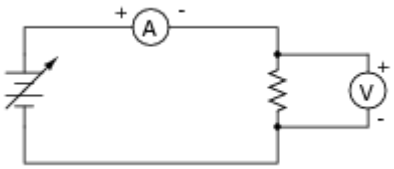
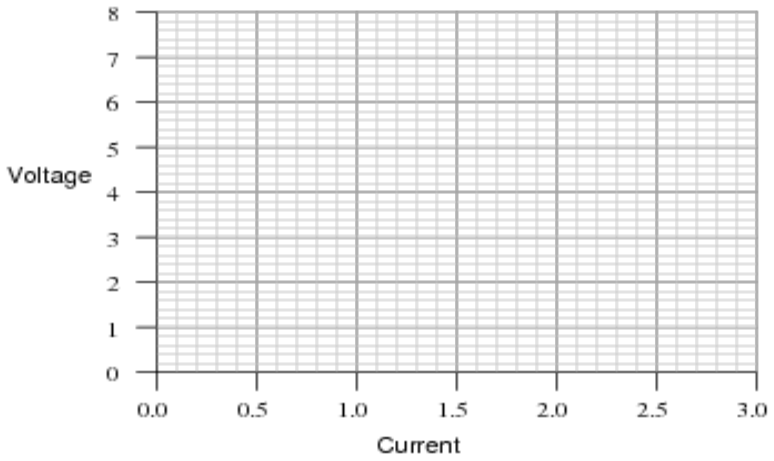


Table of Results

Voltage (V)	*Current (A)*	*Resistance (Ω)*
0.22	*0.66*	*6*
0.47	*1.42*	*6*
0.85	*2.54*	*6*
1.05	*3.16*	*6*
1.50	*4.51*	*6*
1.80	*5.51*	*6*
2.00	*5.99*	*6*
2.51	*7.49*	*6*



1.3 Which mathematical relationship do you see between voltage and current in this simple circuit?

1.4 Use the graph to draw conclusions about the relationship between voltage, current, and resistance.

The learners were expected to analyse the information at their disposal to complete the activity. As the learners were completing the activity, the teacher, as a facilitator, moved around and through Socratic questioning, assisted the learners in completing the activity in their respective groups. While carrying out the activity, the learners were active in their learning, interacting and collaborating with one another in their respective groups. After completion of the activity, the learners were required to present their responses. This process allowed the learners from the different groups to critique each other's responses for more clarity and understanding of Ohm's Law. The teacher used this approach to help the learners to engage, make meaning, and draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The second lesson was better than the first. The teacher showed improvement in using Educational Technologies for a better presentation of the lesson. Using a laptop, a projector, and a whiteboard to display PowerPoint slides, YouTube videos, and simulations, the teacher managed to present the information in multiple forms for better comprehension. Moreover, the teacher manged to create a platform where learners discussed, critiqued, and debated their understanding of new concepts in relation to what they already knew and what had recently learnt, harmonising the new knowledge with their own understanding. He also manged to keep the class interactive and collaborative by actively engaging the learners. As

such, the teacher succeeded in engaging the learners in their acquisition of knowledge on the topic of interest by taking advantage of the affordances of Educational Technologies during the presentation of the lesson.

5.3.2.5 Jolie classroom observation (School E)

The topic for the lesson presentation was based on Electrical Systems and Control focusing on Ohm's Law in a Grade 7 senior-phase Technology classroom. The Educational Technologies used in the lesson presentation were a laptop connected to a projector to display PowerPoint slides, a YouTube video, and a simulation of electricity on the whiteboard.

A. First cycle of classroom observation

- *Interaction with Prior Knowledge*

  The teacher entered the class and greeted the learners. With the help of an assistant teacher, she connected a laptop to a projector, which enabled her to display the lesson presentation on the whiteboard. Despite having these connections at her disposal, the teacher opted to use a hard copy document as her term of reference. The document contained notes explaining concepts that were of importance in the chapter of electricity in Grade 7.

  Using the document as the term of reference, the teacher took learners through the lesson of the day, starting with an introduction of the topic that focused on Ohm's Law and followed by a description of the lesson objectives. Thereafter, the teacher began to pose questions as a way of recapping on the previous lesson and extracting what the learners knew about electricity. The teacher used this approach to elicit learners' prior knowledge on electricity from the previous lesson.

- *Interaction with New Knowledge*

  After eliciting the learners' prior knowledge using a hard copy document, the teacher played a YouTube video; it was played to the end. The video unpacked Ohm's Law and explained the relationships between concepts such as current, voltage, and resistance. Thereafter a video was played that complemented the information disseminated by the YouTube video. Moreover, referring to the hard copy document, the teacher further explained and emphasised important concepts and the relationships between these concepts relative to Ohm's Law. She then

provided a short exercise to engage the learners. She gave them a sheet document with exercises relating to the application of Ohm's Law them to complete.

Exercise:

1. *Fill in the blanks: The current-voltage relationship is indicated by the formula _____*
2. *Ohm's Law is named after which scientist?*
3. *_____ volt of pressure is needed to push one amp of current through one ohm of resistance.*

    a. *Zero*
    b. *One*
    c. *Two*
    d. *Three*

4. *The SI unit of electric resistance is the _____*

    a. *Kelvin*
    b. *Volt*
    c. *Ohm*
    d. *Ampere*

5. *State true or false: Ohm's Law is universal.*

    a. *True*
    b. *False*

As the learners were completing the exercise, the teacher walked around and checked how they were progressing, providing guidance if necessary. The teacher used this approach to help the learners to engage and acquire new knowledge.

- *Construction of Own Knowledge*

After the teacher had concluded the exercise with the learners on Ohm's Law, the teacher displayed a PowerPoint slide with an activity for the learners to complete immediately after the lesson presentation:

Activity

Using the table below, answer the following questions:

a. *What is the trend of voltage from row 2 to 6?*

b. *What is the trend of resistance from row 2 to 4?*
c. *What is the trend of current from row 2 to 4?*
d. *What is the relationship between voltage, resistance, and current?*
e. *What is the trend of voltage from row 5 to 7?*
f. *What is the trend of resistance from row 5 to 7?*
g. *What is the trend of current from row 5 to 7?*
h. *What is the relationship between voltage, resistance, and current?*

Number of cells	*Voltage (V)*	*Resistance (R)*	*Current (I)*
2	*3*	*6*	*0.5*
4	*6*	*6*	*1*
8	*9*	*6*	*1.5*
2	*3*	*12*	*0.25*
6	*6*	*12*	*0.5*
8	*9*	*12*	*0.75*

As the learners were completing the activity, the teacher moved around, guiding the learners through Socratic questioning. After completing the activity, the learners were required in their respective groups to present their answers. During the learners' presentations, the teacher asked questions to which the learners responded as a class rather than as individuals or a group, giving them a platform to explain what they had learnt. The lesson was fun, interactive, and informative. The teacher used this approach to help learners engage, make meaning, and draw their conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The first lesson was good. Using Educational Technologies, the teacher was able to engage the learners actively. The teacher succeeded in eliciting information regarding what the learners knew, in engaging the learners in their acquisition of knowledge, and in providing opportunities for the learners to discover and process information according to their own understanding of the topic of interest. However, this was all to a limited extent, as the teacher did not fully exploit the affordances of Educational Technologies during the presentation, leaving gaps that needed to be filled to improve the presentation of the second lesson. Again, there was a lack of cohesion in the way the content was delivered.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentation of the first lesson. During the observations, the researcher had noted a few areas in the use of Educational Technologies that needed improvement. To better the lesson presentation, the researcher and the teacher agreed that the teacher should design and use PowerPoint presentation slides for the introduction and the unpacking of Ohm's Law. Moreover, explanations for the relationship between current, resistance, and voltage should be provided, and these would complement the YouTube videos that she would use throughout the lesson. The teacher was advised to unpack Ohm's Law before playing the YouTube videos for better cohesion in the delivery of the content. It was also advised that the YouTube videos were played to the end and at least twice for the learners to digest the information. Lastly, instead of verbally presenting the information, the use of simulation was recommended to explain/validate Ohm's Law further and to present a creative lesson, thus enhancing the comprehension of knowledge.

C. Second cycle classroom observation

The same class setup was used, a laptop and whiteboard to display the PowerPoint presentation of slides, YouTube videos, and simulation, to provide flexibility and creativity in the presentation and enhance the comprehension of knowledge.

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as she entered the classroom. With the help of an assistant teacher, she connected the laptop to a projector to enable her presentation to be displayed on the whiteboard. The PowerPoint slides covered all three sections: IPK, INK, and COK. The slides for the first section contained bulleted lists outlining the topic of the day and introducing the lesson objectives. As before, the slides contained well summarised notes on electricity, recapping on what was done in the previous lesson. The second section of the slides presented the advance content on electricity in relation to Ohm's Law. In addition, the slides specified an exercise for the learners to do during the presentation. The slides for the third section presented an activity for the learners to complete immediately after the lesson presentation.

  Using the PowerPoint slides reflecting the first section, the teacher initially presented a brief introduction about what the lesson presentation was all about,

touching on the lesson's topic, the learning objectives, and the importance of electricity in our daily lives. After the introduction, she moved to a slide containing questions that were aimed at recapping on what was covered in the previous lesson and extracting the learners' knowledge on the topic. The questions were based on the use of electricity in homes, looking at different home appliances in terms of their magnitude in the consumption of electricity. The teacher used this method to elicit learners' prior knowledge from the previous lesson in a real-life context.

- *Interaction with New Knowledge*

After eliciting learners' prior knowledge through PowerPoint, the teacher displayed the PowerPoint slides that reflected the second section. The PowerPoint slides contained well-summarised notes unpacking Ohm's Law, explanations describing and demonstrating the relationship between current, resistance, and voltage, and the approach to applying Ohm's Law to solve problems. In addition, the slides included exercises for learners do during the lesson.

Using the PowerPoint slides, the teacher took the learners through the summarised notes, unpacking Ohm's Law and explaining and providing descriptions of the relationship between current, voltage, and resistance in view of Ohm's Law. She also guided the learners on how to use Ohm's Law in problem-solving. To echo the information disseminated using the PowerPoint slides, the teacher thereafter displayed a YouTube video. This was played twice and to the end so that the learners could grasp and digest what the presentation was all about. The teacher then gave the learners a few exercises, thus engaging them in the application of Ohm's Law.

Exercise:

1. *Fill in the blanks: The current-voltage relationship is indicated by the formula* _____
2. *Ohm's Law is named after which scientist?*
3. _____ *volt of pressure is needed to push one amp of current through one ohm of resistance.*

    a. *Zero*
    b. *One*

c. *Two*

d. *Three*

4. *The SI unit of electric resistance is the _____*

   a. *Kelvin*

   b. *Volt*

   c. *Ohm*

   d. *Ampere*

5. *State true or false: Ohm's Law is universal.*

   a. *True*

   b. *False*

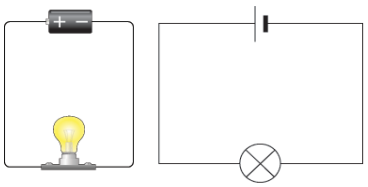
As the learners were completing the exercises, the teacher walked around and checked how the learners were progressing, providing guidance if necessary. The teacher used this approach to help the learners to engage and to acquire new knowledge.

- *Construction of Own Knowledge*

After the teacher had concluded the exercises on Ohm's Law with the learners, she displayed the PowerPoint slides that reflected the third section. The slides had an activity for the learners to complete immediately after the lesson presentation. The activity comprised two parts (before and during/after simulation). See the activity below.

Activity

Part 1



Using the simple circuit diagram above and based on your understanding and knowledge of voltage, current, and resistance, respond to the following question:

If you increase the number of cells to two, three, and four, what happens to the bulb brightness, voltage, current? Use the table below for your responses.

Number of cells	*Bulb Brightness increases/decreases*	*Voltage increases/decreases*	*Current increases/decreases*
2			
3			
4			

The learners responded to the questions displayed in the PowerPoint slide as instructed. After Part 1, the teacher displayed a simulation validating Ohm's Law.

Part 2

In Part 2, the same questions were posed by the teacher but with the difference that in Part 2 of the activity, the learners responded based on their observations when the teacher was conducting the simulation. At the end of the simulation, the teacher guided the learners through a classroom discussion to make comparisons of their responses in Part 1 and Part 2 and to draw their conclusions about the voltage and current in the circuit. The teacher used this approach to help the learners to engage, to make meaning, and to draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The second lesson was better than the first because the teacher showed improvement in her use of Educational Technologies for the lesson presentation. Using Educational Technologies, the teacher managed to present the information in multiple creative forms, resulting in the effective acquisition of knowledge and better comprehension of the information. As such, the teacher succeeded in eliciting learners' prior knowledge; in engaging learners in their acquisition of knowledge; and in creating a platform where learners could discuss, critique, and debate their understanding of new concepts in relation to what they already knew and what had been recently learnt, harmonising the new knowledge with their own understanding. By taking advantage of the affordances of Educational Technologies, the teacher also manged to promote interactive and collaborative learning and actively engage the learners in the topic of interest.

5.3.2.6 Kim classroom observation (School F)

The topic for the lesson presentation in a Grade 9 senior-phase Technology classroom was based on Mechanical Systems and Control focusing on hydraulic systems. The Educational Technologies used in the lesson presentation was a laptop connected to a projector to display the PowerPoint slides and a YouTube video about hydraulics on the whiteboard.

A. First cycle classroom observation

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as she entered the classroom where the connection of a laptop to a projector was already in place, showing that preparations for the lesson had been done beforehand. The teacher displayed a Word document on the whiteboard that had three sections: the section for prior knowledge; the section for new knowledge; and the section for the construction of knowledge. The first section displayed notes recapping on the introduction of hydraulic systems, which had been done in the previous grade. The second section had notes introducing the advance knowledge of hydraulic systems. The third section had an activity covering the topic of hydraulic systems.

  Commencing with her presentation and using the displayed Word document that reflected the first section, the teacher outlined the topic of hydraulic systems as indicated in the document and the objectives of the lesson, clearly stipulating what was to be achieved. Thereafter, she employed a question-and-answer method and engaged the learners by asking questions about hydraulic systems as a way of extracting what the learners knew about hydraulics and recapping on what the learners had covered in the previous grade. The teacher used this method to elicit the learners' prior knowledge from the previous grade.

- *Interaction with New Knowledge*

  After determining the learners' prior knowledge through the Word document, the teacher displayed a YouTube video. The video explained the advance content of hydraulic systems and showed the importance of hydraulic systems in different fields such as healthcare, civil engineering, and mechanical engineering.

The teacher continually played and paused the video, posing questions to the learners in some instances and pausing to place emphasis on certain points or ask questions to seek clarity from the learners in others. At the end of the video, the teacher displayed a Word document that reflected the second section and presented an exercise for the learners to do.

Exercise:

In your respective groups, identify a household tool/mechanism that uses a hydraulic system to operate or to perform a certain task. Explain how it works and what qualifies it to be classified as a hydraulic system.

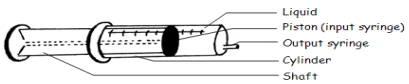
The teacher randomly chose a group to present their responses in relation to the exercise and asked them to clarify where necessary. If she did not agree with what a group presented, she asked them to re-do the exercise. As the learners were completing the exercises, the teacher walked around and checked how the learners were progressing. She guided the groups that were experiencing challenges in completing the exercise by posing guiding questions. This was the approach used by the teacher to engage the learners in newly acquired knowledge about hydraulic systems.

- *Construction of Own Knowledge*

After the learners had completed the exercise, the teacher displayed a YouTube video. The YouTube video named and explained the apparatus that the learners were to use to perform a practical activity to validate Pascal's principle. The video was played to the end. After the video, the teacher requested the learners to collect a practical sheet and the apparatus. The learners were instructed to do the practical and record everything on the practical sheet. While completing the practical, the teacher moved around, checking that the learners were doing the activity and helping them where necessary.

Activity

A syringe can be used to illustrate the way in which a hydraulic system works.



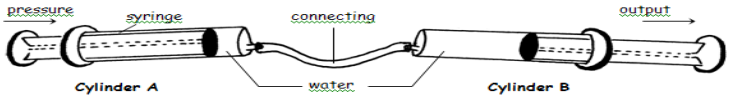
The piston on which the pressure is exerted is called the master or input piston, and the syringe that experiences the effect is called the server or output piston.

1. *In your own words, describe how a hydraulic system works. Give two examples of hydraulic systems that are commonly used.*
2. *To examine the transmission of pressure in a hydraulic system and to be able to describe it, you need the following items:*

- *2 x 10 mℓ plastic syringes marked A and B*
- *1 x plastic tube*

Connect the cylinders as indicated in the figure and fill the system with water.

Wet both ends of the plastic tube and fix it to the syringes as indicated in the drawing.



2.1 Push the plunger of cylinder A to a level of 2 cm deep. Make a note of the observed distance output in cylinder B.

2.2 Push the plunger of cylinder B to a level of 2 cm deep. Make a note of the observed distance output in cylinder A.

2.3 Has any mechanical advantage been observed?

2.4 Summary: The transmission of pressure in a hydraulic system.

At the end of the practical activity, the learners were requested to combine their recoded information, to look for relationships/patterns, and to draw their conclusions. The teacher then randomly chose learners and asked them to present their conclusions. The teacher used this approach to help the learners to engage, to make meaning, and to draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The first lesson was good because through the use of Educational Technologies, the teacher was able to engage the learners actively. The teacher succeeded in eliciting learners' prior knowledge, in engaging the learners in their acquisition of knowledge, and in providing the learners with opportunities to make discoveries and draw conclusions regarding the topic of interest. However, the teacher did not fully exploit the affordances of the Educational Technologies during the

presentation, leaving room for improvement in the presentation of the second lesson.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentation of the first lesson. During the observation, the researcher had noted a few areas that needed improvement such as the limited use of Educational Technologies. To better the lesson presentation, the researcher and the teacher agreed that the teacher should design and use PowerPoint presentation slides for the introduction of the lesson, for exercises, and for the activity and show all the steps that the learners needed to follow when completing the practical activity. Moreover, it was agreed that the video would be played twice to enable the learners to have a better grasp of the information on the video.

C. Second cycle classroom observation

The same class setup was used – the laptop and whiteboard to display the PowerPoint presentation slides and a YouTube video to provide flexibility and creativity in the presentation and comprehension of knowledge.

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as she entered the classroom. A laptop was already connected to a projector, showing that preparations for the class had been done beforehand. The teacher displayed the PowerPoint slides, which reflected the three sections of the lesson presentation: the section for prior knowledge, the section for new knowledge, and the section for the construction of knowledge. The first section of the slides had bulleted lists outlining the lesson and the lesson objectives – what the lesson was all about and what was to be achieved by the end of the lesson. The PowerPoint slides also displayed text covering the concepts of hydraulic systems and 3D pictures of mechanisms in the different classes of hydraulic systems. The second section presented notes introducing the advance knowledge of hydraulic systems. The third section offered an activity relating to the topic of hydraulic systems.

  Using the PowerPoint slides reflecting the first section, the teacher outlined the topic of hydraulics and the learning objectives, explaining the achievements expected by the end of the lesson. After the introduction, she moved to the next slide that presented detailed information on the uses and importance of hydraulic

systems in our daily lives in addition to information on hydraulics dating back to ancient times. leading to modern civilisation. The slides also afforded concepts of hydraulic systems such as pressure, volume, and area. In a whole-class discussion, the teacher engaged the learners by asking some thought-provoking questions and extracted what the learners knew about hydraulics, recapping on what was done by the learners in the previous grade. The teacher used this method to elicit learners' prior knowledge from the previous lesson through a real-life context.

- *Interaction with New Knowledge*

After eliciting learners' prior knowledge using PowerPoint slides, the teacher displayed the PowerPoint slides that reflected the second section. The slides presented notes focusing on the advance topic of hydraulic systems / Pascal's principle. The notes were well summarised and explained/described the relationship between pressure, volume, and area, leading to Pascal's principle and presenting an outline of how to apply Pascal's principle in problem-solving. In addition, the slides offered an exercise for the learners to complete during the lesson and a practical group activity to be completed at the end of the exercise.

Using the displayed set of PowerPoint slides that reflected the second section, the teacher confidently introduced the learners to new concepts, providing explanations and descriptions and unpacking Pascal's principle. She also took the learners through a step-by-step approach to applying the principle in problem-solving. To complement the PowerPoint slides, the teacher thereafter played a YouTube video twice to the end, again unpacking Pascal's principle and showing examples of how to apply it in problem-solving. She then engaged the learners through an exercise displayed on the slides.

> ***Exercise 1:*** *A pressure of 2000 Pa is transmitted throughout a liquid column due to a force being applied on a piston. If the piston has an area of 0.1 m^2, what force is applied?*
>
> ***Exercise 2:*** *In a hydraulic jack, a small piston has a force of 300 N applied to it. The small piston has a cross-sectional area of 10 cm^2. It is connected to a larger piston with a cross-sectional area of 50 cm^2. Calculate the force exerted by the larger piston.*

Exercise 3: *In a hydraulic system, a piston with a force of 700 N is used on an area of 50 cm^2. If this force is applied to a liquid connected to a second piston with an area of 200 cm^2, find the force acting on the second piston.*

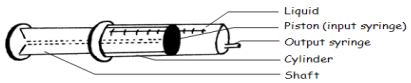
During the learners' completion of the exercises, the teacher moved around, checking how the learners were progressing and helping the learners to complete the exercises through guiding questions. The teacher used this approach to help the learners to engage and acquire new knowledge.

- *Construction of Own Knowledge*

After the learners had concluded the exercises on the application of Pascal's principle in problem-solving, the teacher displayed the PowerPoint slides that reflected the third section. The slides contained an activity that was to be completed by the learners in their respective groups. However, before the learners became engaged in the activity, the teacher played a YouTube video. The YouTube video was preparing the learners for the practical activity. The video named various apparatus and explained how they will used to validate Pascal's principle in the practical activity. The video was played twice to the end so that all the learners could grasp everything they needed to know before they completed the activity. After the video had been played, the teacher requested the learners to collect a practical sheet and the apparatus. The instructions on the practical sheet directed the learners to continue with the practical activity and to record everything on the practical sheet. The teacher then displayed a PowerPoint slide with the activity to be completed by the learners in their respective groups.

Activity

A syringe can be used to illustrate the way in which a hydraulic system works.

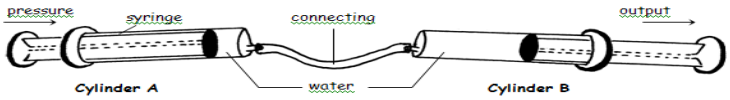


The piston on which the pressure is exerted is called the master or input piston, and the syringe that experiences the effect is called the server or output piston.

1. *In your own words, describe how a hydraulic system works. Give two examples of hydraulic systems that are commonly used.*
2. *To examine the transmission of pressure in a hydraulic system and to be able to describe it, you need the following items:*

- *2 x 10 mℓ plastic syringes marked A and B*
- *1 x plastic tube*

Connect the cylinders as indicated in the figure and fill the system with water. Wet both ends of the plastic tube and fix it to the syringes as indicated in the drawing.



2.1 *Push the plunger of cylinder A to a level of 2 cm deep. Make a note of the observed distance output in cylinder B.*

2.2 *Push the plunger of cylinder B into a level of 2 cm deep. Make a note of the observed distance output in cylinder A.*

2.3 *Has any mechanical advantage been observed?*

2.4 *Summary: The transmission of pressure in a hydraulic system.*

The teacher used the slides to take the learners through every step, reading each step and explaining it to them. The learners performed the activity according to the instructions and made the necessary recordings on the provided practical sheet. The teacher moved around and checked that the learners were doing the activity, helping them where necessary. As part of the activity, the learners were requested to harmonise their recoded information, look for relationships/patterns, and draw their conclusions. All groups were required to present their conclusions. The teacher used this approach to help the learners to engage, make meaning, and draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The second lesson was better than the first because the teacher showed improvement in using the laptop, which was connected to a projector to display the PowerPoint presentations and the YouTube videos. Using Educational Technologies, she managed to present the information in multiple forms for better comprehension. Moreover, the teacher also manged to keep the class interactive by engaging the learners actively. By taking advantage of the affordances of Educational Technologies during the presentation, the teacher succeeded in eliciting prior knowledge, engaging learners in their acquisition of knowledge, and

providing opportunities for the learners to discover and draw their own conclusions about the topic of interest.

5.3.2.7 Kevin classroom observation (School G)

The topic for the lesson presentation was based on Mechanical Systems and Control focusing on pulleys in a Grade 9 senior-phase Technology classroom. The Educational Technologies used in the lesson presentation were a laptop and a smartboard to display animated videos, PowerPoint slides, and YouTube videos.

A. First cycle classroom observation

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as he entered the classroom. He then connected his laptop to the projector for the displays on the smartboard. The teacher had a hard copy document with him that contained notes explaining and describing pulleys and to which he later referred as the lesson progressed.

  Despite having a laptop connected to a projector at his disposal, the teacher opted to introduce the lesson about pulleys verbally using the hard copy document. The teacher started by sharing a brief history of pulleys from ancient to modern times. Thereafter, through a question-and-answer method, he engaged the learners in the use and importance of pulleys systems in industry and in homes. The learners responded to most of the questions, showing that they were knowledgeable about the topic of pulleys. Through the question-and-answer method, the teacher also extracted information on what the learners knew about pulleys and recapped on learners' experience and knowledge from the previous grade regarding pulleys. The teacher used this method to elicit learners' prior knowledge from the previous lesson through a real-life context.

- *Interaction with New Knowledge*

After eliciting the learners' prior knowledge using the hard copy document, the teacher focused on the setup comprising a laptop connected to a projector that was at his disposal. The teacher displayed the first part of an animated video of a young man (cartoon character) who was experiencing challenges when trying to remove a large rock that was in his way and who needed a solution.

Through a question-and-answer method, the teacher engaged the learners in finding possible solutions to the problem that the cartoon character was facing. The learners responded with several different solutions to the challenge faced by the young man. The teacher then played the second part of the animated video that showed the solution to the challenge, which was the use of a pulley by the cartoon character to remove the rock. Thereafter, the teacher engaged the learners in the following exercise on pulleys:

Exercise

In your respective groups, identify a pulley mechanism that is in use daily. Identify the type of pulley (fixed/movable) and briefly explain how it works in providing a mechanical advantage.

As the learners were completing the exercise, the teacher moved around, checking the learners' progress, and helping those who were experiencing challenges in completing the exercise with guiding questions. This was the approach used by the teacher to engage the learners in their acquisition and processing of new knowledge about pulleys.

- *Construction of Own Knowledge*

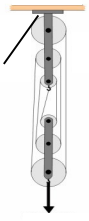
After the teacher had concluded the exercise on pulleys with the learners, he displayed a Word document with an activity that was to be completed by the learners:

Activity 1

1.1 The following questions are based on the pulley system. Choose the correct answer and cross the letter of your choice.

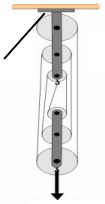
1.1.1 If the load in the pulley system is lifted 12 cm, what distance (in cm) does the rope, where effort is applied, move?

a. 2 cm
b. 24 cm
c. 72 cm
d. 150 cm



1.1.2 What is the mechanical advantage of the pulley system?

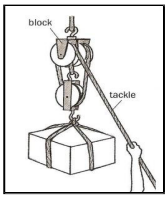
a. 6
b. 25



c. 120

d. 150

1.1.3 What is the mechanical advantage of the compound pulley shown below?



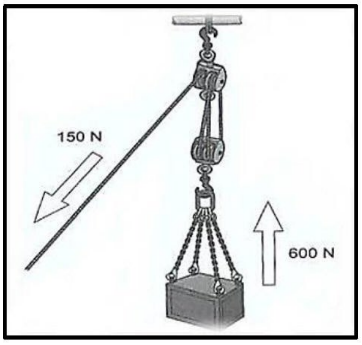
a. 1

b. 3

c. 4

d. 2

1.1.4 Calculate the mechanical advantage of the pulley below.



During the completion of the activity, the learners were expected to analyse the information at their disposal and complete the activity. As the learners were completing the activity, the teacher, as a facilitator, moved around and through Socratic questioning, assisted the learners in completing the activity in their respective groups. However, many learners had challenges in completing the activity and hence, completion of the activity was not a success. In addition, because the lesson time had elapsed, the teacher instructed the learners to complete the activity as homework. The teacher tried to use this approach to help

the learners to engage, make meaning, and draw their conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The first lesson was good; the teacher was able to engage the learners actively. It was a captivating and refreshing lesson. The teacher succeeded in eliciting the learners' prior knowledge and engaging the learners in their acquisition of knowledge on the topic of pulleys, but this was to a very limited extent since he did not fully exploit the affordances of Educational Technologies during the presentation. In addition, the teacher failed to provide opportunities for collaborative and interactive learning. The learners were provided with an activity to complete but due to time constraints, the learners were unable to complete it. The activity was a critical aspect in ensuring that the Construction of Own Knowledge was achieved. Completion of the activity was key in accomplishing this aspect, and since the activity was not completed, the lesson presentation failed to achieve some of the desired objectives. This left many gaps requiring improvement for a better presentation in the second lesson.

B. Reflections

Before the presentation of the second lesson, the researcher and the teacher reflected on the presentation of the first lesson. During the observations, the researcher had noted a few areas that needed improvement, particularly regarding the use of Educational Technologies. The researcher and the teacher agreed that the teacher should design and use a PowerPoint presentation for the introduction and align it with the animated video clip. In addition, it was agreed that instead of verbally presenting the information, the teacher should find and use a YouTube video that complemented the PowerPoint slides. Lastly, they agreed that the teacher must play the animated video immediately after the introduction to the lesson to capture the attention of the learners and to cultivate their curiosity.

C. Second cycle classroom observation

The same class setup comprising the laptop and the whiteboard to display the PowerPoint presentation slides, the animated video, and the YouTube video was used to provide flexibility and creativity in the presentation and to enhance the comprehension of knowledge. Furthermore, the PowerPoint presentation slides were

designed and aligned with the YouTube video, as suggested during the reflection session.

- *Interaction with Prior Knowledge*

  The teacher greeted the learners as he entered the classroom. He then connected his laptop to a projector, which enabled him to project his lesson presentation onto the whiteboard. After he had completed the connection, he wasted no time in displaying the PowerPoint slides. The slides for the lesson presentation consisted of three sections: a section for prior knowledge, a section for new knowledge, and a section for the construction of knowledge. The first section of the slides had bulleted lists outlining the lesson objectives and what was to be achieved by the end of the lesson. The other PowerPoint slides summarised notes explaining/describing concepts of pulleys and 3D pictures of different types of mechanisms that use pulleys to operate or to perform specific tasks. The second section had notes introducing the advance knowledge of pulleys. The third section had an activity covering the topic of pulleys.

  Using the displayed PowerPoint slides reflecting the first section, the teacher introduced the topic of pulleys to the learners and outlined the lesson objectives. After the introduction, the teacher played the animated video. The animated video showed a young man (cartoon character) who was experiencing challenges when trying to remove a large rock that was in his way and who needed a possible solution. After trying several ways to lift/move the rock, the cartoon character ultimately used a rope and a tree that was close to the rock and designed a mechanism – a pulley system – to pull the rock, thus succeeding in removing the rock out of the way. The teacher then displayed the PowerPoint slides that reflected the first section again. Using the slides as part of recapping on past experiences and what was done in the previous grade, the teacher shared a brief history of pulleys from ancient to modern times, with pictures of pulleys from the different ages, different types of pulleys (fixed/movable), and the characteristics regarding mechanical advantage. Thereafter, the teacher engaged the learners using a question-and-answer method to examine issues such as the importance of pulley systems in industry and in our homes. The learners responded to most of the questions, showing that they were knowledgeable on the topic of pulleys. The

teacher used this method to elicit learners' prior knowledge on pulleys from the previous lesson through a real-life context.

- *Interaction with New Knowledge*

After eliciting learners' prior knowledge through PowerPoint and animation, the teacher displayed the PowerPoint slides that reflected the second section. The PowerPoints slides contained the advance content/information on different types of pulleys (fixed/movable); the everyday use of pulleys and their importance to society; and the step-by-step approach to calculating mechanical advantage, velocity ratio, efficiency, and distance load/effort. In addition, the slides had exercises for the learners to do.

Using the PowerPoint slides, the teacher took the learners through the summary, explaining and providing descriptions of the different types of pulleys. The teacher also took the learners through the step-by-step approach to performing calculations for mechanical advantage, velocity ratio, efficiency, and distance load/effort. To complement the information that was presented using slides, the teacher then displayed a YouTube video about the two types of pulleys (i.e., fixed and movable pulleys). The projected YouTube video also showed 3D views of a range of mechanisms that uses pulleys (e.g., curtain blinds, flag poles, chain blogs, gym machines). The teacher played the YouTube video twice to the end without pausing or interrupting to allow the learners to grasp and digest the information being presented. The display provided a better visualisation of the pulleys, enabling a better comprehension of pulleys. At the end of the video, the learners were required to complete the exercises that are shown below.

Exercises:

1. *A pulley system has three pulleys. A load of 120 N is overcome by applying an effort of 50 N. Calculate the mechanical advantage and efficiency of this system.*
2. *A pulley system has a velocity ratio 3 and an efficiency of 80%. Draw a labelled diagram of this pulley system. Calculate the following:*
    a. *the mechanical advantage of the system*
    b. *the effort required to raise a load of 300 N*

As the learners were completing the exercises, the teacher walked around and checked how the learners were progressing. If a group had challenges in completing the exercise, he asked them guiding questions to help them in completing the exercise. This was the approach used by the teacher to engage the learners with new knowledge on pulleys.

- *Construction of Own Knowledge*

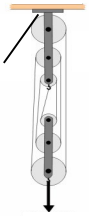
After the teacher had concluded the exercises on pulleys with the learners. The teacher displayed a YouTube video showing learners how to perform calculations on both simple and compound pulleys. The YouTube was played twice to the end to allow learners to grasp and digest the information being presented. He then displayed a PowerPoint slide reflecting the third section. The slide had an activity that was to be completed by the learners in their respective groups immediately after the lesson:

Activity 1

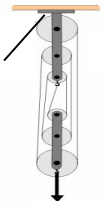
1. *The following questions are based on the pulley system. Choose the correct answer and cross the letter of your choice.*

1.1 If the load in the pulley system is lifted 12cm, what distance (in cm) does the rope, where effort is applied, move?

a. 2 cm
b. 24 cm
c. 72 cm
d. 150 cm

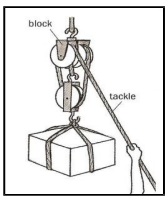


1.2 What is the mechanical advantage of the pulley system?



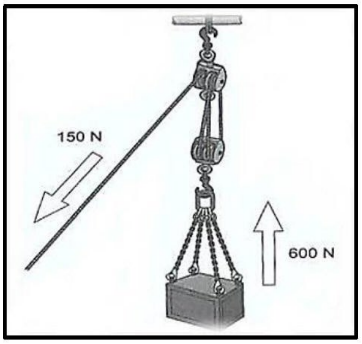
a. 6
b. 25
c. 120
d. 150

1.3 What is the mechanical advantage of the compound pulley shown below?



a. 1
b. 3
c. 4
d. 2

1.4 Calculate the mechanical advantage of the pulley below.



_____
_____
_____
_____
_____
_____
_____
_____

2. A block and tackle system has 5 pulleys. If an effort of 1000 N is needed in the downward direction to raise a load of 4500 N, calculate:

a. the mechanical advantage
b. the velocity ratio
c. the efficiency of the system

As the learners were completing the activity, the teacher moved around and helped them to understand and complete the activity through Socratic dialogue, allowing them to debate, discuss, and critique each other's views. After completion of the

activity, the learners embarked on a mini presentation of their responses. This provided the learners with opportunities to analyse, discuss, debate, and draw their own conclusions. The teacher used this approach to help the learners to engage, make meaning, and draw conclusions, thus building their knowledge.

- *The use of Educational Technologies to present creative lessons*

The second lesson was better than the first. The teacher effected the changes that were suggested during reflection and showed improvement in using the laptop connected to a projector to display the PowerPoint slides, the animated video, and the YouTube video, resulting in a better presentation of the lesson. Using Educational Technologies, he managed to keep the class interactive by actively engaging the learners. As such, the teacher succeeded in eliciting prior knowledge; in enhancing engagement with acquired knowledge; in creating a platform where learners could discuss, critique, and debate their understanding of new concepts in relation to what they already knew and what they had recently learnt, harmonising about pulleys their own understanding. Furthermore, using Educational Technologies, the teacher managed to present information in multiple forms for better presentation and comprehension of knowledge.

5.3.3 Teachers' use of Educational Technologies for lesson presentation

5.3.3.1 Interaction with Prior Knowledge

Teachers use Educational Technologies to present creative lessons. During the presentation of their first lessons, the teachers showed themselves to be knowledgeable on the integration of Technology in teaching and learning. Regarding recapping and extracting knowledge from a previous lesson/grade/experience, most teachers succeeded but only to a limited extent since they did not fully exploit the affordances of the Educational Technologies that were at their disposal. Instead, some teachers used hard copy documents (Word documents) to elicit the learners' prior knowledge. However, two teachers did succeed in eliciting learners' prior knowledge using Educational Technologies. Furthermore, one teacher used simulation to try and extract prior knowledge, but this was confusing because it appeared that new information was being presented instead of extracting prior knowledge from a previous lesson/grade/experience. This was also expressed by Bahari (2022) who found that many teachers still struggle to take full advantage of the affordances of Educational

Technologies, and during lesson presentations, they still waver between traditional methods and modern methods to disseminate information.

During the presentation of the second lesson, most of the teachers showed significant improvement and composure in their use of technologies to elicit the learners' prior knowledge from a previous lesson/grade/experience. All the teachers used a laptop, or a smartphone connected to a projector and a smartboard to display their designed PowerPoint slides to recap and extract learners' prior knowledge from a previous lesson/grade/experience. The use of Technology in this regard enabled the teachers to present information creatively. It also provided them with flexibility in providing descriptions and 3D pictures in tandem for better visualisation of information and better understanding of a specific content. This resonates with the views of Haleem et al. (2022) that the use of Educational Technologies for lesson presentation provides flexibility in terms of how information is shared in a classroom and enables a teacher to use text to provide descriptions and 3D pictures for better visualisation and understanding. In support, Lawrence and Tar (2018) indicate that the integration of Educational Technologies allows the teacher to present information in multiple ways, which enhances how new knowledge is processed for better understanding.

5.3.3.2 Interaction with New Knowledge

Teachers use Educational Technologies to present creative lessons. During the presentation of their first lessons, the teachers showed extensive knowledge. To a limited extent, the teachers used PowerPoint, YouTube, simulations, and animations to engage the learners with new information. Furthermore, when using YouTube videos to disseminate the information, most of the teachers interrupted the flow of information by continually playing and pausing the video. In some cases, the teachers opted to use only one platform instead or two or more to deliver the information (e.g., PowerPoint in tandem with a YouTube video), which would have resulted in better comprehension of the information. However, one teacher used PowerPoint slides and YouTube videos to disseminate the information, and this was fruitful. In addition, presenting information in multiple forms can cover learners' different learning styles. This coincides with the perspective of Haleem et al. (2022) that it is important for teachers to explore all possible benefits that technologies offer to improve the quality of teaching and learning in a classroom.

During the presentation of their second lessons, the teachers showed great improvement and confidence in their use of Technology to engage the learners in new knowledge. All of the teachers opted for more than one way to disseminate information, as they were becoming more accustomed to using technologies to design and present creative lessons. Moreover, their presentations were more logical and coherent because the technologies provided flexibility and multiple ways to engage in new knowledge. Moreover, different learning styles can be covered with the use of Educational Technologies, proving that if the technologies are well integrated, they have much to offer in enhancing the teaching and learning process. This concurs with the views expressed by Bizami et al. (2023) that through the effective integration of Educational Technologies, information can be presented in different platforms or in multiple ways to enhance the teaching and learning process in the classroom.

5.3.3.3 Construction of Own Knowledge

Teachers use Educational Technologies to present creative lessons. During the first lesson, the teachers could not take advantage of the affordances of technologies at their disposal. The teachers used hard copy documents or displayed Word documents, overlooking the better options of presenting information in a more creative way and enhancing the comprehension of the information. However, three teachers did use PowerPoint to provide the learners with a platform to harmonise what they previously knew and what they had currently learnt through an activity. However, the learners of two of the teachers failed to complete the activity due to time constraints, which proved to be detrimental in achieving the desired outcomes. As outlined by Nayar (2018), integrating Educational Technologies into a lesson presentation in the classroom can be a distraction and a time-consuming exercise if the teacher has not been vested with the necessary skills and knowledge regarding how to champion the technologies for their intended purpose.

During the presentations of the second lesson, the teachers succeeded in taking advantage of the affordances of Educational Technologies. They used a range of platforms to disseminate information ranging from YouTube to simulation and PowerPoint. At this stage, all of them used two ways/more to present the information (e.g., PowerPoint and simulations). Moreover, all the teachers had their learners

performing and completing the activity in class as planned, thus enabling the learners to debate, discuss, make discoveries, and draw conclusions regarding certain aspects. This resonates with the views of Kilag et al. (2023) that the use of Educational Technologies is potent in education in many ways such as boosting learners' enthusiasm and engagement and making it easier for them to acquire knowledge and skills. In addition, Munyengabe et al. (2017) assert that since Educational Technologies can be seen as a 'mediator or a bridge' between many elements that impede teaching and learning, their integration is certainly crucial to these processes.

5.3.4 Summary

In this study, the observations that were made were based on the classroom context, and they revealed that most rural schools lack the infrastructure that promotes Creative Teaching with Technology in the classroom. As such, most teachers had to make prior arrangements to transform their classroom environment for the use of Educational Technologies to present creative lessons. However, that did not deter the teachers from their ambition and plans to deliver creative lessons with the integration of Educational Technologies. Designing and redesigning based on reflection helped the teachers with their developmental growth in integrating Educational Technologies to deliver creative lessons. As part of the intervention programme, the teachers were required to deliver multiple lessons, and great improvement was registered in a number of aspects but mainly regarding the use of Educational Technologies to design and present creative lessons.

5.4 SUMMARY OF THE FINDINGS

The aim of this study was exploring the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. As indicated in the previous chapter, the study found that Technology teachers were not using Educational Technologies to design and present creative lessons, as is expected in the digital age. Moreover, the teachers lacked the knowledge and skills on how to integrate Educational Technologies to enhance their Creative Teaching of Technology in the classroom. After a series of lessons were presented by as this was a two-cycle action research the teachers with the guidance of the researcher, it was found that Teachers Creative Teaching Skills can be

improved, developed, and transformed through proper skills development programmes. Another finding was that most of the rural schools lacked ICT infrastructure and resources such as interactive smartboard, projectors, Wi-Fi e.tc. This was evident since most of the teachers, even after the intervention programme, mainly used personal laptops, projectors, and whiteboards to display their lesson presentations, and this may have been influenced by the fact that most rural schools have limited resources and poor ICT infrastructure to allow leeway in the process of selecting Educational Technologies for effective integration. This coincides with the research of Singh (2018) that the lack of infrastructure and ICT resources in schools is often a reason why teachers tend to avoid integrating Educational Technologies in the classroom. The last finding highlighted a lack of policy regarding resources and ICT infrastructure. This was evident in schools where, despite the availability of smart classrooms in some schools, teachers encountered difficulties accessing these spaces due to excessive administrative control. In other cases, teachers faced challenges obtaining basic technological tools such as projectors. In one instance, a teacher had to wait for a colleague to retrieve the school's only projector from their residence, further illustrating the systemic inadequacies in resource allocation and accessibility.

The research findings are summarised below in view of two (RQ3 and RQ4) of the four research questions.

5.4.1 Technology teachers' use of Educational Technologies to design creative lessons and creative activities

As indicated earlier, for this research question, document analysis was used to gather data about Technology teachers' use of Educational Technologies to design creative lessons and creative activities. In the lesson plan analysis, the first finding was that teachers can be good designers of creative lessons if they regularly receive training on new trends and developments that affect classroom practices. It was clearly reflected from the lesson plan analysis that most teachers, through the knowledge gained from participating in the intervention programme by the researcher, acquired knowledge and skills on how to design creative lessons effectively with the integration of Educational Technologies. This was evident when most of the teachers realised that even though they were not provided with a lesson plan template, they could still design

creative lesson plans and cover all aspects of a creative lesson. The holistic development of creative lessons by most teachers reflected the links between topic, learning objectives, instructional strategies, and the integration of Educational Technologies, presenting a clear implementation plan to guide the lesson presentation. This coincides with the view of Bates (2019) that in creative lesson designing, learning objectives, well-structured content, well-managed and controlled workloads, integrated Educational Technologies, relevant learner activities, and assessment that is directly linked to the desired learning outcomes must be considered.

During the activity analysis, the second finding was that teachers can be good designers of creative activities with regular training on contemporary issues that affect classroom practices. The activity analysis clearly indicated that most teachers, through the knowledge gained from participating in the intervention programme presented by the researcher, acquired knowledge and skills on how to design creative activities effectively with the integration of Educational Technologies. The holistic development of creative activities by most teachers reflected the links between topic, learning objectives, instructional strategies, and the integration of Educational Technologies, presenting a clear implementation plan to guide the activity to be executed during the lesson. As expressed by Jalinus et al. (2017), in designing creative activities, aspects such as learning objectives, learning methods and technology integration, and operational procedures of tasks or activities need to be considered.

In view of the above, for both the designed creative lessons and the activities, most of the teachers could clearly show how the Educational Technologies were going to be used to extract learners' prior knowledge; to engage learners in acquiring new knowledge; and to provide a platform for learners to harmonise new and previous knowledge, to make judgements, to take ownership of their learning, and to draw inferences in relation to the topic that is to be presented without the influence of the teacher. Therefore, it is clear that for Creative Teaching to flourish in the classroom in the current era, teachers who through self-efficacy can advantageously brace themselves for eminent changes, transformation, and improvement in instructional classroom practices fuelled by the advancement of Technologies are required. Moreover, maintaining relevance in education during the era of the Fourth Industrial

Revolution means that teachers must find ways to adapt in the digital age. This resonates with the articulations of Malik (2018) that teachers need to take part in skills development programmes to keep up with the rapid growth and advancement of the Technology that defines the changes in classroom practices.

5.4.2 Technology teachers' use of Educational Technologies to present creative lessons

As indicated earlier, in addressing RQ2, non-participant observations were used to gather data about Technology teachers' use of Educational Technologies to present creative lessons. During the non-participatory observation segment, worthy results were attained, as the first finding revealed that teachers are knowledgeable and skilled regarding presenting creative lessons with the use of Educational Technologies. After completing the intervention programme that was facilitated by the researcher, the participants in this study experienced perceptible changes to their teaching practices. The teachers designed and presented lessons more than once, each time showing immense improvement in terms of the selection process and use of Educational Technologies. This was evident since most teachers could use various Educational Technologies to present their lessons, and if properly trained, they could also present information in multiple ways for better comprehension of what was being taught, thus catering for diverse leaning style in the classroom. Mynaříková and Novotný (2020) express that for Educational Technologies to be effectively integrated into the classroom, more time must be dedicated to lesson planning and preparation in addition to exploring new approaches of presenting and sharing information and cooperating with learners.

In summary, teachers' Creative Teaching Skills in the use of contemporary technologies were enhanced, enabling the teachers to perform more effectively in the classroom. These experiences demonstrated that the rapid transformation of classroom practices together with instructional change are of worth. Henceforth, diverse aspects of the teachers' classroom practices and teaching strategies will be altered to match the requirements of the everchanging scenery in teaching that is brought about through the advancement of Technology to suit the content that is being taught. As expressed by Yurtseven Avci et al. (2020), the changes in classroom

practices brought about by the effective integration of Educational Technologies can be seen in researching, planning, and presenting information.

5.5 SUMMARY OF THE CHAPTER

In this chapter, the researcher presented the data and summarised the findings from the study with reference to the research questions. Firstly, the highlights of the document analysis (lesson plan and activity) regarding the use of Educational Technologies to design creative lessons and creative activities were presented. Secondly, the highlights of the non-participant observations on how teachers present creative lessons with the effective integration of Educational Technologies were depicted. Lastly, the research findings in relation to RQ3 and RQ4 were summarised.

The next chapter provides a detailed conclusion. In addition, recommendations in relation to the study findings and the limitations of the study are presented together with a detailed proposed model.

CHAPTER 6: CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS, AND A PROPOSED MODEL

6.1 INTRODUCTION OF THE CHAPTER

In the previous chapter, the presentation of the data and a discussion of the findings in view of the research questions and the data collection instruments were provided.

This chapter provides a broad conclusion regarding the findings in relation to the data presented in Chapter 4 and Chapter 5 and offers recommendations for future research. In addition, the limitations of the study are indicated. Lastly, the study proposes a model that will help in the development of teachers' Creative Teaching Skills.

6.2 SUMMARY OF THE STUDY

The study explored the development of Technology teachers' Creative Teaching Skills through the integration of Educational Technologies in a senior-phase classroom. Teachers' use of Educational Technologies to design and present creative lessons in their classrooms was also investigated. The study developed four research questions. Responding to these questions uncovered the intricacy of the designing and implementation stages in the process of Creative Teaching using Educational Technologies that eventually bring about positive change in classroom practices. The study used the Creative Teaching Approach through the lens of Social Constructivism Theory.

From the perspective of Vygotsky's (1978) theory of Social Constructivism, the study highlighted that through the intervention regarding the use of Educational Technologies in classroom practices, teachers' Creative Teaching Skills and attitudes were transformed. Firstly, the study found that teachers do not use Educational Technologies regularly as is expected in the digital age, and this may be influenced by various factors. Secondly, the study discovered that teachers lacked knowledge and skills concerning the integration of Educational Technologies in their teaching. In the current study, teachers mostly used a laptop and a projector to display PowerPoint slides and 3D pictures as a way of creatively presenting a lesson. However, there are many Educational Technologies available such as interactive smart boards,

simulations, YouTube videos etc. and if well integrated, have much to offer to enhance the teaching and learning process in the classroom. During the selection process of Educational Technologies for the design and presentation of lessons, teachers' decision making was not well informed or principled. It was a process that was based on the teachers' familiarity with the type of Technology. However, a few of the teachers specified that availability and the content to be taught must take precedence when one is selecting Educational Technologies for the design and presentation of a creative lesson.

Thirdly, the study found that Creative Teaching Skills can be developed through appropriate skills development programmes. After training, the teachers showed great improvement in knowledge, skills, and competence in using Educational Technologies for presenting creative lessons. The selection process of Educational Technologies for the design and presentation of lessons, teachers' decision making was well informed and principled. Their selection was guided by various factors such as content, lesson objectives, and learning styles, and the teachers could design lessons, redesign lessons, and present information in multiple ways for better comprehension. During the interviews conducted in this study, the teachers attested to their recent experiences of transformation from traditional methods of teaching to the use of Educational Technologies to present creative lessons. Furthermore, the document analysis (lesson plans and activities) and the visits of the researcher to the classrooms validated these statements.

Fourthly, during the observations of the teachers' lesson presentations, it was uncovered that the lack of ICT infrastructure and the shortage of resources in the schools proved to be limiting factor for teachers' integration of Educational Technologies into their teaching practices in the classroom. However, despite these constraints, the teachers showed determination during the intervention programme to overcome all adversity and persevere with the transformation of their classroom practices. Most of the teachers, therefore, had to use their personal laptops and arrange for projectors and folding mobile whiteboards to transform the classroom space to present creative lessons through the integration of Educational Technologies. In some instances, teachers had to move the learners from one classroom to another

because the first classroom lacked an electrical outlet to make the desired connections. The whole process proved to be time consuming.

Lastly, the study uncovered that there is lack of policy on ICT infrastructure and resources in schools. In addition, some teachers would personalise the schools' few Technology resources (projector, folding whiteboard), not sharing them with other teachers even though they were the property of the school. Only two schools of the seven schools that were visited had a smart classroom, and so access to these spaces was micromanaged. Prior arrangements had to be made to use these spaces since it was the only smart classroom in the entire school. This highlights the need for the DBE to develop/amend ICT infrastructure policy to provide schools with the required infrastructure to support, promote, and allow easy access to ICT resources for all teachers. In view of the deadlock and the issues that were uncovered in relation to teachers' ICT knowledge and skills, ICT infrastructure, and policy in public schools, particularly in rural schools, several recommendations concerning changes in the classroom to support Creative Teaching through the integration of Educational Technologies are made.

6.3 RECOMMENDATIONS OF THE STUDY

6.3.1 Recommendations for classroom practice

- Teachers, as agents of change and transformation in the classroom, should champion the drafting and amendment of policies in schools through the proper channels since they are at the centre of the implementation of policies by the school or departments to achieve curriculum goals.
- Teachers need to normalise the integration of Educational Technologies to improve their knowledge and skills and to enhance their Creative Teaching in the classroom.

6.3.2 Recommendations for policymaking and amendment

- The Ministry of Basic Education should engage all stakeholders and ensure that all schools are provided with the necessary support for teaching and learning with Educational Technologies.

- Educational Technology/ICT policies should be user-friendly and accessible to teachers, as they are at the centre of policy implementation.
- Policies should be timeously reviewed and amended.

Teachers must be held responsible for the implementation of policies and guidelines regarding the use of educational Technology tools. As such, this will cultivate teachers' zeal to use Educational Technologies for Creative Teaching and creative development. Therefore, having policies in place will compel the Ministry of Basic Education to design programmes that are aimed at developing and refining teachers' skills continually.

6.3.3 Recommendations for teacher training

- Teacher Education and Training Institutions (TETIs), particularly in underdeveloped and developing countries, need to offer a module on the integration of Educational Technologies to pre-service teachers.
- The institutions need to design and offer educational programmes (short courses) on teaching with Technology for in-service teachers to ensure that they keep up with recent developments, particularly those that involve teaching and learning with Technology.
- Institutions of education and training should forge partnerships with ministries in their respective countries aimed at supporting teachers through programmes and ongoing training on both current and emerging trends, particularly the advancement of Technology.

6.3.4 Recommendations for infrastructure

The current infrastructure in most schools in South Africa, particularly rural schools, does not support any form of ICT integration. Meeting the minimum standards and requirements to enable the effective integration of Educational Technologies and the transformation of the learning space should be prioritised by the DBE and all other stakeholders. Schools need to have the following resources:

- Classrooms with a permanent smartboard/whiteboard, sound speakers, and a projector installed
- Wi-Fi facilities for internet access

6.3.5 Recommendations for further research

- Additional studies could be conducted to explore more diverse sampling in terms of different types of schools (urban and rural/township).
- A similar study could be carried out with a different learning subject, for example, Mathematics, Life Sciences, and Physical Sciences.
- This study could be expanded to include the use of Educational Technologies for the cultivation of learners' creative thinking skills.

6.4 LIMITATIONS OF THE STUDY

- Firstly, the study was limited to the Limpopo province in South Africa, with all participating teachers and schools located within this region. Expanding the study to include multiple provinces could have provided more diverse perspectives and yielded richer data
- Secondly, the investigation was carried out in rural schools that were inadequately funded and under-resourced regarding ICT facilities and infrastructure for both the learners and the teachers. Including both rural and urban schools in the study may have yielded a more diverse set of insights, thereby enhancing the generalisability of the findings and their relevance for policymakers and practitioners.
- Thirdly, this study employed a qualitative research approach. However, conducting a similar study using a mixed-methods approach could yield richer data, potentially leading to more comprehensive findings and well-informed recommendations.
- Fourthly, in this qualitative study, the study participants were chosen through purposeful and convenience sampling, restricting the research sites to schools that were easily reachable by the researcher. Consequently, the findings may not easily be generalisable to other contexts.

6.5 A PROPOSED MODEL FOR DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES

6.5.1 Preamble and rationale for the proposed model

The Creative Teaching Skills Development Model (CTSD) that is being proposed should be seen as a broad, holistic solution to the numerous challenges identified during the progression of this study. Moreover, the CTSD model should serve as the terms of reference for future engagements between the DBE, the TETIs, the Teacher Internship Collaboration South Africa (TICZA), curriculum implementers, teachers' unions, Technology teachers, and all other stakeholders. The model draws directly from the findings presented in the previous chapters as they connected to the difficulties faced by Technology teachers in creatively presenting a lesson in a Technology classroom with the integration of Educational Technologies as is expected the 21st century.

The conceptualisation of a model with this attribute, and the study that underpinned it, is particularly appropriate given that the DBE is the engine to champion all programmes pertaining to education. The DBE and all other stakeholders need to recognise and value the advancement of Technology and the benefits it brings to the classroom in the current digital age.

6.5.2 Factors that prevent teachers from designing and presenting creative lessons in the classroom

Teachers are at the centre of policy implementation to meet the curriculum requirements. Therefore, it is pivotal that teachers are knowledgeable, skilled, and resourceful regarding issues that have a direct impact on classroom practices. It remains the responsibility of the DBE and all other stakeholders to ensure that teachers are properly developed, trained, and equipped with the necessary skills through skills development programmes, short courses, and content enrichment workshops. This is to make sure that teachers keep up and are comparable with the rest of the world in relation to contemporary issues that have a direct effect on the process of teaching and learning in the classroom. More so, the DBE needs to ensure that schools have the proper ICT infrastructure and resources to enable the teachers

to fulfil the mandate of the department easily and successfully and working policies that will guarantee the achievement of curriculum goals.

6.5.3 Department of Basic Education

One of the top priorities of the South African government, in line with the Constitution and the objectives of the Sustainable Developments Goals, is to guarantee satisfactory and quality education for all (Aruleba & Jere, 2022). Therefore, the Department of Education, as a wing of the South African government, must remain central to everything that pertains to the issues of training, teaching, learning, and policy development and implementation in both primary and secondary schooling for our education to flourish. It is, therefore, crucial for government to make informed appointments of personnel in key positions (Minister, Director General, Provincial MEC, and Head of Department). For instance, the appointment of a minister should be considered in keeping with experience, qualification, expertise, etc. in relation to the function of the ministry. The ministry is not only responsible for the throughput and output of learners, but it carries the future of the country and, therefore, competence must be prioritised. This will contribute greatly to budget allocation, the design and implementation of programmes, and the overall running of the ministry.

The Department of Education, as the engine to promote education, should prioritise the formation of meaningful partnerships with relevant stakeholders such as TETIs, teacher unions and labour unions, the private sector, and industry. This will help the DBE to gather enough support to ensure the success of its programmes for the holistic advancement of education. It cannot be overemphasised that the DBE needs to take a proactive role in teachers' knowledge and skills development. This will enable the teachers, learners, and the country to benefit at an individual level and be globally competitive. Therefore, in relation to the development of teachers' Creative Teaching Skills as seen in the proposed CTSD model, it is crucial to keep in mind that integrating Educational Technologies into the classroom requires more than just technical proficiency, it requires ongoing learning about how to incorporate the technologies into pedagogical practices. Moreover, it should be noted that this can only be accomplished with continued support and education from the school, ministry, and state (Mynaříková & Novotný, 2020). As such, it is important to recognise the hard work of South Africa's provincial education departments in making sure that schools

have access to Technology. However, a shift in perspective is required for government and educational leaders to embrace these technologies properly and see them as a necessary component of economic development, a trend that is accelerating globally (Aruleba & Jere, 2022).

6.5.4 Policy

To foster the development of 21st-century skills, policy should encourage the availability of freely accessible wireless connectivity and individually owned computer devices and smartphones, ICT infrastructure, and resources, etc. (Salemink et al., 2017). The current educational environment is not well resourced to cater for teaching with Technology. The Ministry of Education ought to offer schools adaptable policy initiatives to facilitate cooperative efforts towards implementing the transition from traditional classrooms, which serve as physical spaces for imparting knowledge, to classrooms enhanced by Technology, which offer contextualised and authentic learning experiences. (Kong et al., 2014; Rana, 2017).

Policies on ICT integration show that the institutional vision of the role of ICT in teaching and learning is a key factor for its effective pedagogical integration (Li et al., 2019). The current study determined that in most schools, accessing classroom space or ICT resources and tools is a serious challenge. For many teachers, receiving the necessary support is a lengthy process, and it is unclear whether it is policy or simply individuals within the School Management Team who are not informed by ICT policy exercising their authority. Therefore, it is vital for the DBE and schools to develop ICT infrastructure policies that will ensure that the available infrastructure is not only well managed and maintained but also is widely accessible to teachers and learners to use without difficulty. Moreover, the DBE and schools should make sure that policies are amended timeously to match the curriculum needs. In schools where policy measures were formed jointly among teachers, across departments, and throughout the school, success was obtained in integrating Educational Technologies into teaching (Salam et al., 2018).

6.5.5 ICT infrastructure and resources

The integration of Technology into 21st-century education necessitates the preparation of several facilities and infrastructure (Anikweze & Kanu, 2018). Moreover,

integrating Educational Technologies to improve teaching and learning in the classroom requires a suitable infrastructure and the availability of technical and pedagogical support (Rana & Rana, 2020). This study found that teachers may have difficulty in championing the effective integration of Educational Technologies because of poor infrastructure. During the observations, it was evident that many schools, particularly rural schools, lack the appropriate ICT infrastructure and resources that enable teachers to integrate and use Educational Technologies in their teaching with relative ease. When integrating Educational Technologies into teaching and learning, certain prerequisites must be met, including the availability of ICT infrastructure, support, and access. This was confirmed by Moloi and Mhlanga (2021) who stated that many teachers in rural areas relied on the old-fashioned teaching techniques such as chalkboards and whiteboards because there was little digital infrastructure available for teaching, learning, and keeping up with the changing environment brought about by the advancement of Technology.

In South Africa, infrastructure development of schools remains the responsibility of the DBE. The ministry needs to develop schools to meet at least the basic requirements of 21st-century ICT infrastructure. The infrastructure may require a classroom space with the following: electricity, adequate lighting and ventilation, interactive smartboard, curtain/blinds, projector, high-speed internet/Wi-Fi, and computers/laptops/tablets. The school will also need a diesel-powered generator or a solar system that will power the school in times of loadshedding or load reduction. However, it remains the responsibility of the school to make sure that the infrastructure is well manged, secured, and maintained for longevity. However, this is a challenging undertaking for schools because of the significant financial commitment in terms of security, maintenance, etc., resulting in a situation whereby the classroom/laboratory is locked if the particular teacher who is deemed responsible is not available, thus denying access to other teachers. It would be better for the department to provide schools with a technician who would be responsible for managing the infrastructure, performing basic training on how to use the gadgets and connections, assisting with the connections when the teachers needed to use the space and resources, and providing security to safeguard the school property. This would encourage the efficient use of the school resources by the teachers. Therefore, for teachers to integrate Educational Technologies in learning settings effectively, proper infrastructure support is required

(Dinc, 2019). Moreover, school facilities and infrastructure must be available and ready for use in 21st-century education since they have a huge impact on the teaching and learning process in the classroom (Göçen et al., 2020).

6.5.6 Teacher Education and Training Institutions

If adequate training is not provided to enhance the skills of teachers in terms of development, installation, and maintenance, the provision of ICT infrastructure in the nation and other developing nations will be of minimal significance (Aruleba & Jere, 2022). Therefore, it is pivotal for TETIs to design short learning programmes that are aimed at introducing teachers to the integration of Educational Technologies in the classroom (Moloi & Mhlanga, 2021). Teacher Education and Training Institutions are institutions that oversee the training and skills development of teachers to satisfy the curriculum needs. In South Africa, these institutions work under the banner of the Department of Higher Education and Training (DHET) and alongside the South African Qualifications Authority (SAQA) and other bodies to ensure that the training offered by the institutions is high quality and standardised.

Numerous studies have demonstrated that even in cases where technological infrastructures and devices are made available in rural areas, teachers are not equipped with the necessary skills to integrate them into their teaching (Aruleba & Jere, 2022). Hence, since Technology is constantly evolving, there will always be a gap between the pedagogical potential of the newest products available on the market and the Technology that is already available in the school. Therefore, it may not be helpful to consider only the standard concepts such as hardware, software, and infrastructure but also the training that is required to create the pedagogy relating to them (Collins, 2017; Collins & Halverson, 2018). The current study found that the teachers lacked the knowledge and skills on how to integrate Educational Technologies for Creative Teaching. Therefore, the TETIs, in conjunction with both the DHET and the DBE, need to ensure that teachers are offered training that directly responds to their needs. Over the years, intervention programmes have been conducted by various TETIs, but they have failed to respond to the needs of the teacher or the curriculum. This coincides with the findings of Tunjera and Chigona (2020) that while there were technological interventions available, they were often of a broad spectrum. As such, they did not train teachers sufficiently to use the

Educational Technologies in their contexts. To support the ongoing transformation and application of teaching practices that are desired in the digital era, the Ministry of Education should collaborate with the TETIs and offer sustainable and scalable teacher development to both pre-service and in-service teachers (Arrington, 2021; Kong et al., 2014). Moreover, the training on the use of these technologies for teaching and learning needs to be strengthened (Mhlanga & Moloi, 2021). Hence, teacher training is an essential component of transforming the traditional teaching approach, but it cannot be implemented in a vacuum or without addressing problems such as computer anxiety, the lack of knowledge on how to use Educational Technologies in each subject, the lack of school support, and the lack of confidence when using Educational Technologies.

6.5.7 Teacher unions

Teacher unions, as labour unions, should not only advocate remuneration for teachers but also advocate new trends that affect the process of teaching and learning. They should advocate the continual training of teachers aimed at transforming teachers' skills and knowledge on current classroom practices (i.e., integration of Educational Technologies and artificial intelligence in education). Furthermore, the unions should also play a role in encouraging their members (teachers) to participate in the skills development programmes that are offered by the DBE or the TETIs. During their programmes, they need to invite relevant bodies to deliver presentations on current issues that directly affect the teaching and learning process in the classroom.

6.5.8 Private sector

As part of a community engagement/service, the public sector needs to reach out to public rural schools. In South Africa, the private sector provides better support for urban schools than rural schools and, therefore, urban schools are better resourced than rural schools. Some schools have been provided with the proper ICT infrastructure (smart classrooms and Wi-Fi) by the private sector. However, these resources are becoming more of a burden to the schools than a solution to their needs because of the financial commitment that is required and which the school cannot afford. A better solution than donating the resources would be for the private sector to ensure that the infrastructure is well secured, managed, always used, and accessible

to teachers. This could be done through the provision of a technician who would be responsible for the use and running of the infrastructure in addition to providing the needed security measures. This would ensure that the infrastructure that is donated to a school serves its correct purpose.

6.6 PROPOSED MODEL FOR GUIDANCE ON DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES

The proposed model provides guidance on how to carry out the process of developing teachers' Creative Teaching Skills through the integration of Educational Technologies. This is in line with the set of skills that are much needed to succeed in the 21st century. The model is fundamental to the development of creative thinking skills, critical thinking skills, collaboration, communication skills, etc., all of which are defined as 21st-century skills. The integration of Educational Technologies for Creative Teaching is pivotal in ensuring that the current system of education produces the type of learners who will be able to compete and be global participants in the global economy.

Therefore, the skills development of teachers is important not only for the education of learners and the economy of the globe but also for growth sustainability in all professions. Consequently, teachers on their own will not succeed in this venture and require the support of the DBE, the DHET, TETIs, and all other stakeholders to effect the necessary changes in the classroom that will ultimately reach beyond the classroom/school setting – hence, the need for the CTSD model. The model that is proposed by the researcher was informed by the findings of the study and appears in Figure 6.1 below.

Figure 6.1: Creative Teaching Skills Model

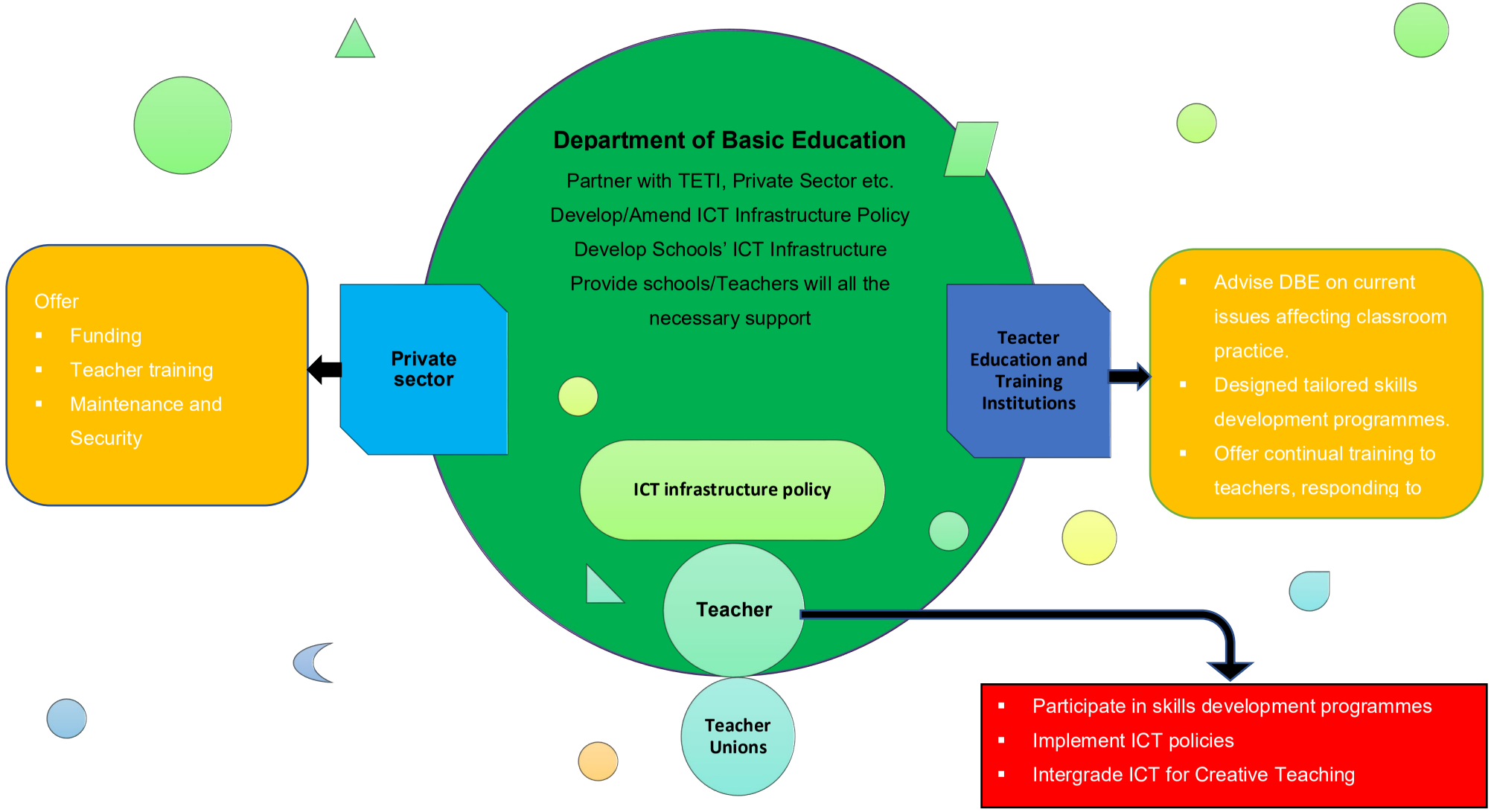


Figure 6.1 CTSD Model

6.6.1 Explanation of the proposed model

The design of the proposed model is based on the fact that teachers are central to policy meeting curriculum implementation in the classroom. Therefore, teachers need to be resourceful, knowledgeable, and skilled in the areas that are decisive and have a direct impact on the teaching and learning process in the classroom. As such, different stakeholders need to be involved to ensure that teachers are well trained, particularly on the integration of Educational Technologies. It remains the responsibility of the DBE to ensure that teachers are provided with the necessary training and skills through developmental programmes and the support that comes with partnerships with stakeholders. As such, it is also important for teachers to take advantage of the opportunities that are offered by the DBE and the TETIs and that are aimed at developing their knowledge and skills.

Partnerships between the Ministry of Education and the TETIs are crucial for the holistic development of teachers' knowledge and skills for good classroom practices (Adeosun, 2014; Magudu & Gumbo, 2018). Therefore, to address teachers' knowledge and skills development for Creative Teaching properly through the integration of Educational Technologies, the model proposes a form of partnership with the stakeholders that will encourage a consultative approach. Together, the DBE and the TETIs, through their parallel roles, can easily champion for the development of teachers' knowledge and skills through relevant skills development programmes.

Considering the above, schools' infrastructure, transformation and development remains important and hence, it is encapsulated in the proposed model together with issues of policy. Policy is another aspect that must be considered because in the development of education policy, amendments and implementation is key to the achievement of curriculum goals.

6.6.2 Role of the Department of Basic Education and the school

The model makes provision for the DBE to take the lead in issues that pertain to the training and development of teachers' knowledge and skills. For the proposed model to be effective, the DBE needs to forge meaningful partnerships with the TETIs and private sector to improve working relationships for a common goal. The partnerships will enable interaction and the sharing of information on the frustrations and failures of

the department regarding issues relating to the integration of Educational Technologies in the classroom. The partnerships would also ensure that the DBE provides funding and other necessary support for the TETIs to offer programmes that are informed and that respond to the needs of the teachers. All the entities have a pivotal role in ensuring proper training and the development of teachers and hence, their partnerships are a crucial aspect of the proposed model.

6.6.3 Role of Teacher Education and Training Institutions

The model makes provision for TETIs to accept their role in defining the teacher training and development programmes. For the proposed model to be effective, the TETIs, through their partnerships with the DBE, need to contribute their skills, knowledge, and expertise. The TETIs need to design and offer proper training that is informed by research. Though the partnerships, the TETIs need to offer the DBE their insights concerning new trends and developments that directly affect classroom practices, given the everchanging world of Technology. It is, therefore, important that as we are advocating the integration of Technology in the classroom for better teaching and comprehension of knowledge, we also keep up with new developments to be comparable with the rest of the world, and the TETIs are in a better position to foster that. As such, this should be a continual process, given the fact that new Educational Technologies evolves continuously.

6.6.4 Infrastructure development and transformation

For the proposed model to be effective, the DBE needs to transform the infrastructure of schools in such a way that it will complement the training offered by the TETIs and meet the needs of teachers. Through the findings of this study, it was clear that most schools, particularly rural schools, lack the ICT infrastructure that will enable teachers to integrate Educational Technologies for Creative Teaching in their classrooms. Thus, even if teachers receive proper training from the TETIs, it would be futile if the school infrastructure did not cater for or enable the teachers to use their knowledge and skills on Technology Integration to enhance the teaching and learning process in the classroom.

Recommended actions to address this challenge include the transformation of the classroom space to encompass the basic requirements of a smart classroom (i.e., electricity, adequate lighting and ventilation, an interactive smartboard, curtain/blinds, a projector, high-speed internet/Wi-Fi, and computers/laptops/tablets with a backup diesel-powered generator/solar system/electrical inverter). This would motivate the teachers to use Educational Technologies in their teaching after receiving training.

6.6.5 Policy development and amendments

The model makes provision for the DBE and schools to prioritise and champion for the development, amendment, and proper implementation of ICT infrastructure policy. For the proposed model to be effective, the DBE, through the schools, needs to ensure that policy on the maintenance of ICT infrastructure and the access to resources is developed or amended. If well implemented, policy will guide and ensure that teachers have the necessary resources for the integration of Educational Technologies into their teaching practices to achieve curriculum goals.

6.7 SUMMARY OF THE CHAPTER

This chapter offered a broad conclusion together with recommendations, limitations of the study, and the proposed model that was derived from the findings in relation to the data presented in Chapter 4 and Chapter 5. The chapter commenced with an all-inclusive conclusion pertaining to the findings. Thereafter, the recommendations, also informed by the findings of the study, were outlined. These were followed by the limitations of the study, demonstrating all the shortcomings that were noted during and after the study, and lastly, a detailed account of the proposed model was presented.

REFERENCES

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). *NMC Horizon Report: 2017 Higher Education Edition*. New Media Consortium.

Adams, V. M., Game, E. T., & Bode, M. (2014). Synthesis and review: Delivering on conservation promises: The challenges of managing and measuring conservation outcomes. *Environmental Research Letters*, *9*(8), 085002. http://dx.doi.org/10.1088/1748-9326/9/8/085002

Adegbenro, J. B., Gumbo, M. T., & Olakanmi, E. E. (2017). In-service secondary school teachers' technology integration needs in an ICT-enhanced classroom. *Turkish Online Journal of Educational Technology*, *16*(3), 79–87.

Adeosun, O. (2014). *Teacher education programmes and the acquisition of 21st century skills: Issues and challenges in Nigeria*. University of Lagos, Nigeria.

Adom, D., Yeboah, A., & Ankrah, A. K. (2016). Constructivism philosophical paradigm: Implication for research, teaching and learning. *Global Journal of Arts Humanities and Social Sciences*, *4*(10), 1–9.

Ahlin, E. M. (2019). *Semi-structured interviews with expert practitioners: Their validity and significant contribution to translational research*. http://dx.doi.org/10.4135/9781526466037

Al-Ababneh, M. (2020). Linking ontology, epistemology and research methodology. *Science & Philosophy*, *8*(1), 75–91.

Alejandro, P., & David, I. (2018). Educational research and innovation teachers as designers of learning environments. In *The importance of innovative pedagogies*. OECD Publishing. https://doi.org/10.1787/g272b194c2-en

Al-Maawali, W. (2020). Affordances in educational technology: Perceptions of teachers and students in Oman. *Journal of Information Technology Education. 19*, 931. https://doi.org/10.28945/4662

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher educators' use of digital tools and needs for digital competence in higher education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203–220. https://doi.org/10.1080/21532974.2019.1646169

Amineh, R. J., & Asl, H. D. (2015). Review of constructivism and social constructivism. *Journal of Social Sciences, Literature and Languages*, *1*(1), 9–16.

Amutha, D. (2020). The role and impact of ICT in improving the quality of education. http://dx.doi.org/10.2139/ssrn.3585228

Anagün, S. S. (2018). Teachers' perceptions about the relationship between 21st century skills and managing constructivist learning environments. *International Journal of Instruction*, *11*(4), 825–840. https://doi.org/10.12973/iji.2018.11452a

Anagün, Ş. S., Atalay, N., & Kandemir, C. M. (2018). E-Portfolio implementation experiences of prospective primary school teachers. *Turkish Online Journal of Qualitative Inquiry*, *9*(2), 102–124. https://doi.org/10.17569/tojqi.397652

Anikweze, C. M., & Kanu, A. C. (2018). Information and communication technology (ICT) and 21st century education in Nigeria*. International Journal of Innovation and Research in Educational Sciences, 5*(6), 2349–5219.

Antoni, N. (2010). Exploring EFL teachers' strategies in teaching reading comprehension. *Jurnal Penelitian Pendidikan*, *11*(2), 39–51. http://www.jurnal.upi.edu/file/5-Nurman_Antoni.pdf

Antonietti, C., Schmitz, M. L., Consoli, T., Cattaneo, A., Gonon, P., & Petko, D. (2023). Development and validation of the ICAP Technology Scale to measure how

teachers integrate technology into learning activities. *Computers & Education*, *192*, 104648. https://doi.org/10.1016/j.compedu.2022.104648

Archambault, L., Leary, H., & Rice, K. (2022). Pillars of online pedagogy: A framework for teaching in online learning environments. *Educational Psychologist*, *57*(3), 178–191. https://doi.org/10.1080/00461520.2022.2051513

Arrington, A. (2021). *The use of information and communications technology to continue instruction and professional development in rural Ghana during COVID-19 school lockdowns.* [Doctoral dissertation]. University of Illinois Urbana-Champaign.

Aruleba, K., & Jere, N. (2022). Exploring digital transforming challenges in rural areas of South Africa through a systematic review of empirical studies. *Scientific African*, *16*, e01190. https://doi.org/10.1016/j.sciaf.2022.e01190

Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2021). Integration of e-learning technologies for interactive teaching and learning process: An empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education*, *13*(3), 649–663. https://doi.org/10.1108/JARHE-04-2020-0103

Ashton, S., & Stone, R. (2021). An AZ of creative teaching in higher education.

Aslan, A., Silvia, S., Nugroho, B. S., Ramli, M., & Rusiadi, R. (2020). Teacher's leadership teaching strategy supporting student learning during the Covid-19 disruption. *Nidhomul Haq: Jurnal Manajemen Pendidikan Islam*, *5*(3), 321–333. https://doi.org/10.31538/ndh.v5i3.984

Astarina, A. N. (2020). Teachers' lesson plans in different school levels (a descriptive research of three different school levels). *Journal of English Language*

Teaching, Literature and Applied Linguistics, *2*(1), 1–15. https://doi.org/10.37742/jela.v2i1.16

Babbie, E. R. (2020). *The practice of social research* (15th ed.). Cengage Learning.

Backfisch, I., Lachner, A., Hische, C., Loose, F., & Scheiter, K. (2020). Professional knowledge or motivation? Investigating the role of teachers' expertise on the quality of technology-enhanced lesson plans. *Learning and Instruction*, *66*, 101300. https://doi.org/10.1016/j.learninstruc.2019.101300

Badiee, M., Wang, S. C., & Creswell, J. W. (2012). Designing community-based mixed methods research. In D. K. Nagata, L. Kohn-Wood, & L. A. Susuki (Eds.), *Qualitative strategies for ethnocultural research* (pp. 41–59). American Psychology Association. https://doi.org/10.1037/13742-003

Bahari, A. (2022). Teacher identity in technology-assisted language learning: Challenges and affordances. *E-Learning and Digital Media*, *19*(4), 396–420. https://doi.org/10.1177/2042753022109285

Bahari, A. (2023). Affordances and challenges of technology-assisted language learning for motivation: A systematic review. *Interactive Learning Environments*, *31*(9), 5853–5873. https://doi.org/10.1080/10494820.2021.2021246

Barak, M. (2017). Science teacher education in the twenty-first century: A pedagogical framework for technology-integrated social constructivism. *Research in Science Education*, *47*, 283–303. https://doi.org/10.1007/s11165-015-9501-y

Barrett, M. S., Creech, A., & Zhukov, K. (2021). Creative collaboration and collaborative creativity: A systematic literature review. *Frontiers in Psychology*, *12*, 713445. https://doi.org/10.3389/fpsyg.2021.713445

Bates, A. W. (2019). *Teaching in a digital age: Guidelines for designing teaching and learning* (2nd ed.). Tony Bates Associates. https://pressbooks.bccampus.ca/teachinginadigitalagev2/

Bayram-Jacobs, D., Henze, I., Evagorou, M., Shwartz, Y., Aschim, E. L., Alcaraz-Dominguez, S., Barajas, M., & Dagan, E. (2019). Science teachers' pedagogical content knowledge development during enactment of socioscientific curriculum materials. *Journal of Research in Science Teaching*, *56*(9), 1207–1233. https://doi.org/10.1002/tea.21550

Beardsley, M., Albó, L., Aragón, P., & Hernández-Leo, D. (2021). Emergency education effects on teacher abilities and motivation to use digital technologies. *British Journal of Educational Technology*, *52*(4), 1455–1477. https://doi.org/10.1111/bjet.13101

Bedir, H. (2019). Pre-service ELT teachers' beliefs and perceptions on 21st century learning and innovation skills (4Cs). *Journal of Language and Linguistic Studies*, *15*(1), 231–246. https://doi.org/10.17263/jlls.547718

Bender, T. (2023). *Discussion-based online teaching to enhance student learning: Theory, practice and assessment*. Taylor & Francis.

Bharati, B. (2023). Exploring Bhutanese geography teachers' perception on the use of information and communications technology in teaching before, during and beyond pandemic. *Asian Journal of Education and Social Studies*, *46*(2), 1–13. https://doi.org/10.9734/ajess/2023/v46i2997

Bindu, C. N. (2016). Impact of ICT on teaching and learning: A literature review. *International Journal of Management and Commerce Innovations*, *4*(1), 24–31.

Bizami, N. A., Tasir, Z., & Kew, S. N. (2023). Innovative pedagogical principles and technological tools capabilities for immersive blended learning: A systematic literature review. *Education and Information Technologies*, *28*(2), 1373–1425. https://doi.org/10.1007/s10639-022-11243-w

Blayi, M., Skosana, N., & Khoza, S. (2022). Teachers' Pedagogical Content Knowledge in Technical Schools: The Case of Domestic Installation and Wiring Teaching. *Research in Social Sciences and Technology*, *7*(3), 36-48. https://doi.org/10.46303/ressat.2022.17

Blose, P., & Gumbo, M. T. (2024). Developing a framework for integrating IKS in technology education with sustainable development principles. *African Journal of Research in Mathematics, Science and Technology Education*, *28*(3), 330-342. https://doi.org/10.1080/18117295.2024.2356416

Bondarouk, T. V. (2006). Action-oriented group learning in the implementation of information technologies: Results from three case studies. *European Journal of Information Systems*, *15*(1), 42–53. https://doi.org/10.1057/palgrave.ejis.3000608

Boonmoh, A., Jumpakate, T., & Karpklon, S. (2021). Teachers' perceptions and experience in using technology for the classroom. *Computer-Assisted Language Learning Electronic Journal*, *22*(1), 1-24.

Borodina, T., Sibgatullina, A., & Gizatullina, A. (2019). Developing creative thinking in future teachers as a topical issue of higher education. *Journal of Social Studies Education Research*, *10*(4), 226–245. https://www.learntechlib.org/p/216563/

Brooks, A. L. (2010). Intelligent decision-support in virtual reality healthcare and rehabilitation. In S. Brahnam, & L. C. Jain (Eds.), *Advanced computational*

intelligence paradigms in healthcare 5 (pp. 143–169). Springer. https://doi.org/10.1007/978-3-642-16095-0_8

Camacho, A., Alves, R. A., & Boscolo, P. (2021). Writing motivation in school: A systematic review of empirical research in the early twenty-first century. *Educational Psychology Review*, *33*(1), 213–247. https://doi.org/10.1007/s10648-020-09530-4

Camilleri, M. A., & Camilleri, A. C. (2017). Digital learning resources and ubiquitous technologies in education. *Technology, Knowledge and Learning*, *22*, 65–82. https://doi.org/10.1007/s10758-016-9287-7

Carey, M. (1994) The group effect in focus groups: Planning, implementing, and interpreting focus group research. In J. Morse (Ed.), *Critical issues in qualitative research methods* (pp. 225–241). SAGE.

Carpenter, C. C. (2019). *A district-wide structured professional development and its impact on technology integration in the classroom*. [Doctoral thesis]. Dallas Baptist University.

Carr-Chellman, A. (2016). Strategic planning in e-learning. *eLearn*, *2016*(5). https://doi.org/10.1145/2936727.293917

Cho, J. Y., & Lee, E. H. (2014). Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences. *Qualitative Report*, *19*(32). https://doi.org/10.46743/2160-3715/2014.1028

Ciesielska, M., Boström, K. W., & Öhlander, M. (2018). Observation methods. In M. Ciesielska, & D. Jemielniak (Eds.), *Qualitative methodologies in organization studies* (pp. 33–52). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-65442-3_2

Clark, J. S., Porath, S., Thiele, J., & Jobe, M. (2020). *Action research*. New Prairie Press.

Coghlan, D. (2019). *Doing action research in your own organization*. SAGE. pp. 1–240.

Collins, A. (2017). *What's worth teaching?: Rethinking curriculum in the age of technology*. Teachers College Press.

Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America*. Teachers College Press.

Collins, C. S., & Stockton, C. M. (2018). The central role of theory in qualitative research. *International journal of qualitative methods*, *17*(1), 1609406918797475. https://doi.org/10.1177/1609406918797475

Corbin, J., & Strauss, A. (2008). Strategies for qualitative data analysis. In J. Corbin, & A. Strauss (Eds.), *Basics of qualitative research: Techniques and procedures for developing grounded theory.* SAGE. https://doi.org/10.4135/9781452230153

Cremin, T. (2022). Teaching english creatively. In *Teaching English Creatively* (pp. 1-11). Routledge.

Creswell JW. (2013). Qualitative inquiry and research design: Choosing among five approaches. (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE.

Crosby, R. H. J. (2000). AMEE Guide No 20: The good teacher is more than a lecturer-the twelve roles of the teacher. *Medical Teacher*, *22*(4), 334–347. https://doi.org/10.1080/014215900409429

Das, K. (2019). The role and impact of ICT in improving the quality of education: An overview. *International Journal of Innovative Studies in Sociology and Humanities*, *4*(6), 97–103.

De Hei, M., Strijbos, J. W., Sjoer, E., & Admiraal, W. (2016). Thematic review of approaches to design group learning activities in higher education: The development of a comprehensive framework. *Educational Research Review*, *18*, 33–45. https://doi.org/10.1016/j.edurev.2016.01.001

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement (CAPS): Technology Grades 7–9.* Pretoria: Department of Basic Education. Available at: https://www.education.gov.za/Curriculum/CAPS.aspx

Department of Basic Education. (2014). *Curriculum and Assessment Policy Statement (CAPS): Technology Grades 7–9.* Pretoria: Department of Basic Education. Available at: https://www.education.gov.za/Curriculum/CAPS.aspx

Devi, K. S. (2019). Constructivist approach to learning based on the concepts of Jean Piaget and Lev Vygotsky: An analytical overview*. Journal of Indian Education, XLIV*(4).

Dew, J. K., Jr., & Foreman, M. W. (2020). *How do we know?: An introduction to epistemology*. InterVarsity Press. https://doi.org/10.1111/rsr.17162

Dinc, E. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology*, *10*(4), 381–398. https://doi.org/10.30935/cet.634187

Dlamini, R., & Mbatha, K. (2018). The discourse on ICT teacher professional development needs: The case of a South African teachers' union. *International Journal of Education and Development using ICT*, *14*(2).

Dukuzumuremyi, S., & Siklander, P. (2018). Interactions between pupils and their teacher in collaborative and technology-enhanced learning settings in the inclusive classroom. *Teaching and Teacher Education*, *76*, 165–174. https://doi.org/10.1016/j.tate.2018.08.010

Earthy, S., & Cronin, A. (2008). Narrative analysis. In N. Gilbert (Ed.), *Researching social life* (3rd ed., pp. 420–439). SAGE.

Ekberg, S., & Gao, S. (2018). Understanding challenges of using ICT in secondary schools in Sweden from teachers' perspective. *International Journal of Information and Learning Technology*, *35*(1), 43–55. https://doi.org/10.1108/IJILT-01-2017-0007

Elmaadaway, M. A. N., & Abouelenein, Y. A. M. (2023). In-service teachers' TPACK development through an adaptive e-learning environment (ALE). *Education and Information Technologies*, *28*(7), 8273–8298. https://doi.org/10.1007/s10639-022-11477-8

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*(1), 53. https://doi.org/10.1186/s41239-021-00289-4

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. https://doi.org/10.11648/j.ajtas.20160501.11

Eyyam, R., & Yaratan, H. S. (2014). Impact of use of technology in mathematics lessons on student achievement and attitudes. *Social Behavior and Personality: An International Journal*, *42*(1), 31S–42S. https://doi.org/10.2224/sbp.2014.42.0.S31

Farjon, D., Smits, A., & Voogt, J. (2019). Technology integration of pre-service teachers explained by attitudes and beliefs, competency, access, and experience. *Computers & Education*, *130*, 81–93. https://doi.org/10.1016/j.compedu.2018.11.010

Fatahi, S. (2019). An experimental study on an adaptive e-learning environment based on learner's personality and emotion. *Education and Information Technologies*, *24*(4), 2225–2241. https://doi.org/10.1007/s10639-019-09868-5

Feng, L., & Zhang, W. (2022). Design and implementation of computer-aided art teaching system based on virtual reality. Computer-Aided Design and Applications, 20(S1), 56-65. https://doi.org/10.14733/cadaps.2023.S1.56-65

Flynn, R., Albrecht, L., & Scott, S. D. (2018). Two approaches to focus group data collection for qualitative health research: Maximizing resources and data quality. *International Journal of Qualitative Methods*, *17*(1). https://doi.org/10.1177/1609406917750781

Garrido, D. R. (2022). What is the phenomenological ontology of forms of life?. In J. Rivera (Ed.), *Explaining phenomenology* (p. 95). World Philosophy Series. Nova Science Publishers.

Ghorbani, S., Jafari, S. E. M., & Sharifian, F. (2018). Learning to be: Teachers' competences and practical solutions: A step towards sustainable development. *Journal of Teacher Education for Sustainability*, *20*(1), 20–45. https://doi.org/10.2478/jtes-2018-0002

Göçen, A., Eral, S. H., & Bücük, M. H. (2020). Teacher perceptions of a 21st century classroom. *International Journal of Contemporary Educational Research*, *7*(1), 85–98. https://doi.org/10.33200/ijcer.638110

Goodyear, P., & Dimitriadis, Y. (2013). *In medias res:* Reframing design for learning. *Research in Learning Technology*, *21*. https://doi.org/10.3402/rlt.v21i0.19909

Goosen, L., & Van Heerden, D. (2017). Beyond the horizon of learning programming with educational technologies. In *Proceedings of the South Africa International Conference on Educational Technologies* (pp. 78–90).

Gorichanaz, T. (2017). Applied epistemology and understanding in information studies. *Information Research: An International Electronic Journal*, *22*(4), n4.

Grant, C., & Osanloo, A. (2014). Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your "house". *Administrative Issues Journal*, *4*(2), 4. https://doi.org/10.5929/2014.4.2.9

Gray, D. E. (2021). *Doing research in the real world* (3rd ed.). SAGE. pp. 1–100.

Guerrero-Roldán, A. E., & Noguera, I. (2018). A model for aligning assessment with competences and learning activities in online courses. *The Internet and Higher Education*, *38*, 36–46. https://doi.org/10.1016/j.iheduc.2018.04.005

Gumbo, M. T. (2014). An action research pilot study on the integration of indigenous technology in technology education. *Mediterranean Journal of Social Sciences*, *5*(10), 386–392. https://doi.org/10.5901/mjss.2014.v5n10p386

Gunter, G. A., & Reeves, J. L. (2017). Online professional development embedded with mobile learning: An examination of teachers' attitudes, engagement and dispositions. *British Journal of Educational Technology*, *48*(6), 1305–1317. https://doi.org/10.1111/bjet.12490

Häkkinen, P., Järvelä, S., Mäkitalo-Siegl, K., Ahonen, A., Näykki, P., & Valtonen, T. (2017). Preparing teacher-students for twenty-first-century learning practices

(PREP 21): A framework for enhancing collaborative problem-solving and strategic learning skills. *Teachers and Teaching*, *23*(1), 25–41. https://doi.org/10.1080/13540602.2016.1203772

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hamilton, B. (2022). *Integrating technology in the classroom: Tools to meet the needs of every student*. International Society for Technology in Education.

Hammarberg, K., Kirkman, M., & De Lacey, S. (2016). Qualitative research methods: When to use them and how to judge them. *Human Reproduction*, *31*(3), 498–501. https://doi.org/10.1093/humrep/dev334

Harmandaoğlu Baz, E., Balçıkanlı, C., & Cephe, P. T. (2018). Introducing an innovative technology integration model: Echoes from EFL pre-service teachers. *Education and Information Technologies*, *23*, 2179–2200. https://doi.org/10.1007/s10639-018-9711-9

Harris, A., & De Bruin, L. (2018). An international study of creative pedagogies in practice in secondary schools: Toward a creative ecology. *Journal of Curriculum and Pedagogy*, *15*(2), 215-235. https://doi.org/10.1080/15505170.2018.1457999

Hassaan, G. A. (2014). Innovation of mechanical machinery in medieval centuries, part IV: Mechanisms, gear trains and cranes. *Innovation*, *2*(4).

Henriksen, D., Creely, E., Henderson, M., & Mishra, P. (2021). Creativity and technology in teaching and learning: A literature review of the uneasy space of implementation. *Educational Technology Research and Development*, 1–18. https://doi.org/10.1007/s11423-020-09912-z

Henriksen, D., Henderson, M., Creely, E., Carvalho, A. A., Cernochova, M., Dash, D., & Mishra, P. (2021). Creativity and risk-taking in teaching and learning settings: Insights from six international narratives. *International Journal of Educational Research Open*, *2*(2), 1–11. https://doi.org/10.1016/j.ijedro.2020.100024

Henriksen, D., Mishra, P., & Fisser, P. (2016). Infusing creativity and technology in 21st century education: A systemic view for change. *Journal of Educational Technology & Society*, *19*(3), 27–37. http://www.jstor.org/stable/jeductechsoci.19.3.27

Henriksen, D., Richardson, C., & Shack, K. (2020). Mindfulness and creativity: Implications for thinking and learning. *Thinking Skills and Creativity*, *37*, 100689. https://doi.org/10.1016/j.tsc.2020.100689

Huang, R., Spector, J. M., & Yang, J. (2019a). *Educational technology: A primer for the 21st century*. Springer Nature.

Huang, R., Spector, J. M., Yang, J. (2019b). Introduction to educational technology. In R. Huang, J. M. Spector, & J. Yang (Eds.), *Educational technology: A primer for the 21st century* (pp. 3–31). Springer Nature.

Huda, M., Maseleno, A., Shahrill, M., Jasmi, K. A., Mustari, I., & Basiron, B. (2017). Exploring adaptive teaching competencies in big data era. *International Journal of Emerging Technologies in Learning*, *12*(3). https://doi.org/10.3991/ijet.v12i03.6434

Hussin, A. A. (2018). Education 4.0 made simple: Ideas for teaching. *International Journal of Education and Literacy Studies*, *6*(3), 92–98. https://doi.org/10.7575/aiac.ijels.v.6n.3p.92

Inel Ekici, D. (2018). Development of pre-service teachers' teaching self-efficacy beliefs through an online community of practice. *Asia Pacific Education Review*, *19*, 27–40. https://doi.org/10.1007/s12564-017-9511-8

Jabeen, R. (2024). AN ANALYSIS OF TECHNOLOGY-BASED MATERIALS FOR COMPUTERSCIENCE INSTRUCTION. *Spectrum of engineering sciences*, *2*(2).

Jackson, N., & Lassig, C. (2020). Exploring and extending the 4C model of creativity: Recognising the value of an ed-c contextual-cultural domain. *Creative Academic Magazine*, (15), 47–63.

Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The seven steps of project-based learning model to enhance productive competences of vocational students. In *Proceedings of the International Conference on Technology and Vocational Teachers (ICTVT 2017)* (pp. 251–256). Atlantis Press. https://doi.org/10.2991/ictvt-17.2017.43

Jatileni, C., & Jatileni, M. (2018). *Teachers' perception on the use of ICT in teaching and learning: A case of Namibian primary education.* [Master's thesis]. Itä-Suomen yliopisto, Finland.

Jha, A. (2017). ICT pedagogy in higher education: A constructivist approach. *Journal of Training and Development*, *3*, 64–70. https://doi.org/10.3126/jtd.v3i0.18232

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and technology acceptance model. *Journal of Educational Technology & Society*, *21*(3), 48–59. https://www.jstor.org/stable/26458506

Kakeeto, D. (2021). *Utilizing a social constructivist approach to cultivate teacher-educators' and trainees' digital competence at Makerere University.* [Doctoral dissertation]. Makerere University, Uganda.

Kale, U., Roy, A., & Yuan, J. (2020). To design or to integrate? Instructional design versus technology integration in developing learning interventions. *Educational Technology Research and Development, 68*, 2473–2504. https://doi.org/10.1007/s11423-020-09771-8

Kalina, C., & Powell, K. C. (2009). Cognitive and social constructivism: Developing tools for an effective classroom. *Education*, *130*(2), 241–250.

Kalolo, J. F. (2019). Digital revolution and its impact on education systems in developing countries. *Education and Information Technologies*, *24*, 345–358. https://doi.org/10.1007/s10639-018-9778-3

Kamath, M., & Kumar, A. (2023). 7 E's of constructivism in e-learning skills of university faculty. *International Journal of Case Studies in Business, IT and Education*, *7*(1), 62–73. https://doi.org/10.47992/IJCSBE.2581.6942.0246

Kampylis, P., & Berki, E. (2014). *Nurturing creative thinking*. International Academy of Education. pp.1–28.

Kanematsu, H., & Barry, D. M. (2016). *STEM and ICT education in intelligent environments* . Springer. (pp. 9–13). https://doi.org/10.1007/978-3-319-19234-5

Kaplan, D. E. (2019). Creativity in education: Teaching for creativity development. *Psychology*, *10*(2), 140–147. https://doi.org/10.4236/psych.2019.102012

Keengwe, J. (2018). Globalization, digital technology, and teacher education in the United States. In *Oxford Research Encyclopedia of Education*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.366

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research.* Springer. https://doi.org/10.1007/978-981-4560-67-2

Kharade, K., & Thakkar, R. (2017). Exploring the pedagogical potential of ICT mediation for promoting students' engagement: A social constructivist perspective. *International Journal of Digital Society*, *3*(2), 629–635. https://doi.org/10.20533/ijds.2040.2570.2012.0076

Khodabakhshzadeh, H., Hosseinnia, M., Moghadam, H. A., & Ahmadi, F. (2018). EFL teachers' creativity and their teaching's effectiveness: A structural equation modelling approach. *International Journal of Instruction*, *11*(1), 227–238. https://doi.org/10.12973/iji.2018.11116a

Kilag, O. K. T., Segarra, G. B., De Gracia, A. M. L., Del Socorro, A. S., Abendan, C. F. K., Camangyan, G. A., & Mahasol, E. T. (2023). ICT application in teaching and learning. *Science and Education*, *4*(2), 854–865.

Kimmons, R., Graham, C. R., & West, R. E. (2020). The PICRAT model for technology integration in teacher preparation. *Contemporary Issues in Technology and Teacher Education*, *20*(1), 176–198.

King, N., Horrocks, C., & Brooks, J. (2018). *Interviews in qualitative research*. SAGE.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, *6*(5), 26–41. https://doi.org/10.5430/ijhe.v6n5p26

Koehler, M. J., & Mishra, P. (2014). Introducing TPCK. In M. J. Koehler, & P. Mishra (Eds), *Handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 13–40). Routledge. https://doi.org/10.4324/9781315759630

Koh, J. H. L. (2019). TPACK design scaffolds for supporting teacher pedagogical change. *Educational Technology Research and Development*, *67*(3), 577–595. https://doi.org/10.1007/s11423-018-9627-5

Kola, M. I. (2015). *How teachers actualise critical thinking skills in the technology classroom* [Doctoral dissertation]. University of Pretoria.

Kolb, L. (2017). *Learning first, technology second: The educator's guide to designing authentic lessons*. International Society for Technology in Education.

Kong, S. C., Chan, T. W., Griffin, P., Hoppe, U., Huang, R., Kinshuk, Looi, C. K., Milrad, M., Norris, C., Nussbaum, M., Sharples, M., So, W. M. W., Soloway, E., & Yu, S. (2014). E-learning in school education in the coming 10 years for developing 21st century skills: Critical research issues and policy implications. *Journal of Educational Technology & Society*, *17*(1), 70–78. https://www.jstor.org/stable/jeductechsoci.17.1.70

Krom, A., & van den Hoven, M. (2022). A quality checklist for responsible conduct of research (RCR) education: A proposal to complement the predictive modeling tool. *Accountability in Research,* *29*(1), 26–44. https://doi.org/10.1080/08989621.2021.1887736

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, *7*(6), e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

Labrique, A. B., Kirk, G. D., Westergaard, R. P., & Merritt, M. W. (2013). Ethical issues in mHealth research involving persons living with HIV/AIDS and substance abuse. *AIDS Research and Treatment*, *2013*(1), 189645. https://doi.org/10.1155/2013/189645

Larison, K. D. (2022). On beyond constructivism: Using intersubjective approaches to promote learning in the science classroom. *Science & Education*, *31*(1), 213–239. https://doi.org/10.1007/s11191-021-00237-8

Lavia, L., Witchel, H. J., Aletta, F., Steffens, J., Fiebig, A., Kang, J., Howes, C., & Healey, P. G. (2018). Non-participant observation methods for soundscape design and urban planning. In F. Aletta, & J. Xiao (Eds.), *Handbook of research on perception-driven approaches to urban assessment and design* (pp. 73–99). IGI Global. https://doi.org/10.4018/978-1-5225-3637-6.ch004

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, *55*(1), 79–105. https://doi.org/10.1080/09523987.2018.1439712

Lee, J., Lim, C., & Kim, H. (2017). Development of an instructional design model for flipped learning in higher education. *Educational Technology Research and Development*, *65*, 427–453. https://doi.org/10.1007/s11423-016-9502-1

Li, S., Yamaguchi, S., Sukhbaatar, J., & Takada, J. I. (2019). The influence of teachers' professional development activities on the factors promoting ICT integration in primary schools in Mongolia. *Education Sciences*, *9*(2), 78. https://doi.org/10.3390/educsci9020078

Liang, K., Susilo, W., & Liu, J. K. (2015). Privacy-preserving ciphertext multi-sharing control for big data storage. *IEEE Transactions on Information Forensics and Security*, *10*(8), 1578–1589. https://doi.org/10.1109/TIFS.2015.2419186

Lin, C. S., & Wu, R. Y. W. (2016). Effects of web-based creative thinking teaching on students' creativity and learning outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(6), 1675–1684. https://doi.org/10.12973/eurasia.2016.1558a

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* SAGE. https://doi.org/10.1016/0147-1767(85)90062-8

Lincoln, Y. S., & Guba, E. G. (2005). *Naturalistic inquiry*. SAGE.

Lucas, B., & Spencer, E. (2017). *Teaching creative thinking: Developing learners who generate ideas and can think critically (Pedagogy for a Changing World series)*. Crown House Publishing.

Magudu, S., & Gumbo, M. T. (2018). Efficacy of the partnership between teacher education institutions and primary schools in teacher preparation in Zimbabwe. *South African Journal of Higher Education*, *32*(5), 104–123. https://doi.org/10.20853/32-5-2595

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. https://doi.org/10.1016/j.sbspro.2014.01.824

Malik, R. S. (2018). Educational challenges in 21st century and sustainable development. *Journal of Sustainable Development Education and Research*, *2*(1), 9–20. https://doi.org/10.17509/jsder.v2i1.12266

Manti, S., & Licari, A. (2018). How to obtain informed consent for research. *Breathe*, *14*(2), 145–152. https://doi.org/10.1183/20734735.001918

Mapotse, T. A. (2014). An emancipation paradigm through critical theory in technology education: An action learning paradigm. *Mediterranean Journal of Social Sciences*, *5*(3), 502. https://doi.org/10.5901/mjss.2014.v5n3p502

Margolis, A. A. (2020). Zone of proximal development, scaffolding and teaching practice. *Cultural-Historical Psychology*, *16*(3). https://doi.org/10.17759/chp.2020160303

Mathabata, L. N., Kola, M. I., & Mtshali, T. I. (2022). Simulations for junior engineering and technology students: teachers' ability to use design process to promote psychomotor skills. *Nigerian Journal of Technology*, *41*(6), 930-939. http://dx.doi.org/10.4314/njt.v41i6.2

Mayer, R. E. (2019). Computer games in education. *Annual Review of Psychology*, *70*(1), 531–549. https://doi.org/10.1146/annurev-psych-010418-102744

Mayring, P. (2014). Qualitative content analysis: Theoretical foundation, basic procedures and software solution. https://nbn-resolving.org/urn:nbn:de:0168-ssoar-395173

Mayring, P. (2019, September). Qualitative content analysis: Demarcation, varieties, developments. *Forum: Qualitative Social Research,* 20(3). Freie Universität Berlin.

McCulloch, A. W., Hollebrands, K., Lee, H., Harrison, T., & Mutlu, A. (2018). Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons. *Computers & Education*, *123*, 26-40. https://doi.org/10.1016/j.compedu.2018.04.008

McLafferty, I. (2004). Focus group interviews as a data collecting strategy. *Journal of Advanced Nursing*, *48*(2), 187–194. https://doi.org/10.1111/j.1365-2648.2004.03186.x

Meintjes, H., & Grosser, M. (2010). Creative thinking in prospective teachers: The status quo and the impact of contextual factors. *South African Journal of Education*, *30*(3), 361–386. https://hdl.handle.net/10520/EJC32245

Merriam, S. B., & Grenier, R. S. (Eds.). (2019). *Qualitative research in practice: Examples for discussion and analysis*. John Wiley & Sons.

Mertler, C. A. (2024). *Action research: Improving schools and empowering educators*. Sage Publications.

Mohammed, S. H., & Kinyó, L. (2020). The role of constructivism in the enhancement of social studies education. *Journal of Critical Reviews*, *7*(7), 249–256. https://doi.org/10.31838/jcr.07.07.41

Moloi, T., & Mhlanga, D. (2021). Key features of the fourth industrial revolution in South Africa's basic education system. *Journal of Management Information & Decision Sciences*, *24*(5).

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), 17. http://dx.doi.org/10.5751/ ES-08663-210317

Moorhouse, B. L., & Wong, K. M. (2022). Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *Journal of Computers in Education*, *9*(1), 51-70. https://doi.org/10.1007/s40692-021-00195-8

Morel, G. M., & Spector, J. M. (2022). *Foundations of educational technology: Integrative approaches and interdisciplinary perspectives* (3rd ed.). Routledge. https://doi.org/10.4324/9781003268406

Morrison, G. R., Ross, S. J., Morrison, J. R., & Kalman, H. K. (2019). *Designing effective instruction*. John Wiley & Sons.

Munyengabe, S., Yiyi, Z., Haiyan, H., & Hitimana, S. (2017). Primary teachers' perceptions on ICT integration for enhancing teaching and learning through the implementation of one laptop per child program in primary schools of

Rwanda. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(11), 7193–7204. https://doi.org/10.12973/ejmste/79044

Murati, R., & Ceka, A. (2017). The use of technology in educational teaching. *Journal of Education and Practice*, *8*(6), 197–199.

Murtafiah, W., Sa'dijah, C., Tjang, D. C., & Susiswo, S. (2019). Decision making of the winner of the national student creativity program in designing ICT-based learning media. *TEM Journal*, *8*(3), 1039.

Mynaříková, L., & Novotný, L. (2020). Knowledge society failure? Barriers in the use of ICTs and further teacher education in the Czech Republic. *Sustainability*, *12*(17), 6933. https://doi.org/10.3390/su12176933

Naik, G. L., Deshpande, M., Shivananda, D. C., Ajey, C. P., & Manjunath Patel, G. C. (2021). Online teaching and learning of higher education in India during COVID-19 emergency lockdown. *Pedagogical Research*, *6*(1). https://doi.org/10.29333/pr/9665

Nayar, A. (2018). *Teaching and learning in technology empowered classrooms—Issues, contexts and practices*. Partridge Publishing.

Nazgul, K., Anar, B., Baglan, Z., Moldir, S., Sadvakasova, G., & Nishanbayeva, S. (2020). Preservıce teachers' opinions on the use of technology in education. *International Journal of Emerging Technologies in Learning*, *15*(23), 182–192. https://doi.org/10.3991/ijet.v15i23.18831

Nazlidou, I., Efkolidis, N., Kakoulis, K., & Kyratsis, P. (2024). Innovative and Interactive Technologies in Creative Product Design Education: A Review. *Multimodal Technologies and Interaction*, *8*(12), 107. https://doi.org/10.3390/mti8120107

Ndwandwe, K. P., Ramaligela, M. S., & Mtshali, T. I. (2024). Smartboard enhanced creativity in the technology classroom: lessons on mechanical systems and

control. *Jurnal Pendidikan Teknologi dan Kejuruan*, *30*(1), 145-156 https://doi.org/10.21831/jptk.v30i1.72289

Nicolaou, C., Matsiola, M., & Kalliris, G. (2019). Technology-enhanced learning and teaching methodologies through audiovisual media. *Education Sciences*, *9*(3), 196. https://doi.org/10.3390/educsci9030196

Nikolopoulou, K. (2018). Creativity and ICT: Theoretical approaches and perspectives in school education. In T. Mikropoulos (Ed.), *Research on e-learning and ICT in education: Technological, pedagogical and instructional perspectives* (pp. 87–100). Springer. https://doi.org/10.1007/978-3-319-95059-4_5

Nkosi, P. B. (2020). *An exploration of creative thinking skills in the Grade 9 technology classroom.* [Master's thesis]. University of Limpopo.

Nkosi, P. B., & Mtshali, T. I. (2024). Enacting Creative Thinking Skills Using Design Process in Technology Classrooms. Futurity Education, 4(4), 123-136. https://doi.org/10.57125/FED.2024.12.25.08

Nkosi, P. B., & Ramaligela, S. M. (2025). The Use of Educational Technologies for Creative Teaching in South African Technology Classrooms: A Social Constructivist Approach. *Jurnal Paedagogy*, *12*(2), 252-262. https://doi.org/10.33394/jp.v12i2.14886

Nnebue, C. C. (2010). Informed consent in research. *Afrimedic Journal*, *1*(1), 5–10.

O'Donoghue, T. (2018). *Planning your qualitative research thesis and project: An introduction to interpretivist research in education and the social sciences*. Routledge. https://doi.org/10.4324/9781351165563

Oliveira, A., Feyzi Behnagh, R., Ni, L., Mohsinah, A. A., Burgess, K. J., & Guo, L. (2019). Emerging technologies as pedagogical tools for teaching and learning

science: A literature review. *Human Behavior and Emerging Technologies*, *1*(2), 149-160. https://doi.org/10.1002/hbe2.141

O'Neal, L. J., Gibson, P., & Cotten, S. R. (2017). Elementary school teachers' beliefs about the role of technology in 21st-century teaching and learning. *Computers in the Schools*, *34*(3), 192–206. https://doi.org/10.1080/07380569.2017.1347443

Palak, D., & Walls, R. T. (2009). Teachers' beliefs and technology practices: A mixed-methods approach. *Journal of Research on Technology in Education*, *41*(4), 417–441. https://doi.org/10.1080/15391523.2009.10782537

Pan, H. L. W., Nyeu, F. Y., & Cheng, S. H. (2017). Leading school for learning: Principal practices in Taiwan. *Journal of Educational Administration*, *55*(2), 168–185. https://doi.org/10.1108/JEA-06-2016-0069

Papanikolaou, K., Makri, K., & Roussos, P. (2017). Learning design as a vehicle for developing TPACK in blended teacher training on technology enhanced learning. *International Journal of Educational Technology in Higher Education*, *14*, 1–14. https://doi.org/10.1186/s41239-017-0072-z

Parchoma, G., Koole, M., Morrison, D., Nelson, D., & Dreaver-Charles, K. (2019). Designing for learning in the Yellow House: A comparison of instructional and learning design origins and practices. Query sheet. *Higher Education Research & Development. 39*, 1–16. https://doi.org/10.1080/07294360.2019.1704693.

Phellas, C. N., Bloch, A., & Seale, C. (2011). Structured methods: Interviews, questionnaires and observation. In C. Seale (Ed.), *Researching society & culture* (3rd ed.). SAGE.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, *24*(7), 5–12. https://doi.org/10.3102/0013189X0240070

Player-Koro, C. (2012). Factors influencing teachers' use of ICT in education. *Education Inquiry*, *3*(1), 93–108. https://doi.org/10.3402/edui.v3i1.22015

Pollard, V., Hains-Wesson, R., & Young, K. (2018). Creative teaching in STEM. *Teaching in Higher Education*, *23*(2), 178–193. https://doi.org/10.1080/13562517.2017.1379487

Pritchard, A., & Woollard, J. (2010). *Psychology for the classroom: Constructivism and social learning*. Psychology for the classroom series. Routledge.

Raihan, M. A., & Han, S. L. (2012). Technology integration for meaningful learning-the constructivist view. *Bangladesh Educational Journal*, *11*(1), 17–37.

Ramaligela, M. S., Gaigher, E., & Hattingh, A. (2014). Exploring the use of technology textbooks in medium- and well-resourced school contexts in South Africa. *Africa Education Review*, *11*(2), 183–200. https://doi.org/10.1080/18146627.2014.927156

Rana, K. B. (2017). *Use of educational technologies in teaching and learning activities: Strategies and challenges-A Nepalese case.* [Master's thesis]. University of Oslo.

Rana, K., & Rana, K. (2020). ICT integration in teaching and learning activities in higher education: A case study of Nepal's teacher education. *Malaysian Online Journal of Educational Technology*, *8*(1), 36–47. https://doi.org/10.17220/mojet.2020.01.003

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher

presence and learning activity. *Postdigital Science and Education*, *2*, 923–945. https://doi.org/10.1007/s42438-020-00155-y

Ratheeswari, K. (2018). Information communication technology in education. *Journal of Applied and Advanced Research*, *3*(1), 45–47. https://dx.doi.org/10.21839/jaar.2018.v3S1.169

Rodriquez, N. N., DiSanto, J., Varelas, A., Brennan, S., Wolfe, K., & Lalongo, E. (2017). Building understanding of high school students' transition to college. *International Journal of Teaching and Learning in Higher Education*, *29*(2), 402–411.

Ronen, I. K. (2020). Action research as a methodology for professional development in leading an educational process. *Studies in Educational Evaluation*, *64*, 100826. https://doi.org/10.1016/j.stueduc.2019.100826

Roulston, K., & Choi, M. (2018). Qualitative interviews. In U. Flick (Ed.), *The SAGE handbook of qualitative data collection* (pp. 233–249). SAGE. https://doi.org/10.4135/9781526416070.n15

Rutten, L. A. (2015). Data collection: Treat every variable as a treasure. *Homeopathy*, *104*(3), 190–196. https://doi.org/10.1016/j.homp.2014.11.002

Salam, S., Zeng, J., Pathan, Z. H., Latif, Z., & Shaheen, A. (2018). Impediments to the integration of ICT in public schools of contemporary societies: A review of literature. *Journal of Information Processing Systems*, *14*(1). https://doi.org/10.3745/JIPS.04.0062

Saldaña, J. (2021). *The coding manual for qualitative researchers*. SAGE.

Salemink, K., Strijker, D., & Bosworth, G. (2017). Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in

rural areas. *Journal of Rural Studies*, *54*, 360–371. https://doi.org/10.1016/j.jrurstud.2015.09.001

Santos, J. M., & Castro, R. D. (2021). Technological pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Sciences & Humanities Open*, *3*(1), 100110. https://doi.org/10.1016/j.ssaho.2021.100110

Sari, U., Duygu, E., Sen, Ö. F., & Kirindi, T. (2020). The effects of STEM education on scientific process skills and STEM awareness in simulation based inquiry learning environment. *Journal of Turkish Science Education*, *17*(3), 387–405. https://doi.org/10.36681/

Sawyer, K. (2019). *The creative classroom: Innovative teaching for 21st-century learners*. Teachers College Press.

Sawyer, R. K. (2011). What makes good teachers great? The artful balance of structure and improvisation. In R. K. Sawyer (Ed.), *Structure and Improvisation in Creative Teaching* (pp. 1–24). Cambridge University Press. https://doi.org/10.1017/cbo9780511997105.002

Schacter, J., Thum, Y. M., & Zifkin, D. (2006). How much does creative teaching enhance elementary school students' achievement?. *Journal of Creative Behavior*, *40*(1), 47–72. https://doi.org/10.1002/j.2162-6057.2006.tb01266.x

Schavemaker, P., & Van der Sluis, L. (2025). *Electrical power system essentials*. John Wiley & Sons.

Seechaliao, T. (2017). Instructional strategies to support creativity and innovation in education. *Journal of Education and Learning*, *6*(4), 201–208. https://doi.org/10.5539/jel.v6n4p201

Selfa-Sastre, M., Pifarré, M., Cujba, A., Cutillas, L., & Falguera, E. (2022). The role of digital technologies to promote collaborative creativity in language education. *Frontiers in Psychology*, *13*, 828981. https://doi.org/10.3389/fpsyg.2022.828981

Shahid, F., Aleem, M., Islam, M. A., Iqbal, M. A., & Yousaf, M. M. (2019). A review of technological tools in teaching and learning computer science. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(11), em1773. https://doi.org/10.29333/ejmste/109611

Shamsudin, N. Yusoff, N. (2014). Systematic review on teaching methodologies for the infusion of creative science classroom. *Journal of Educational Research, Faculty of Education, UiTM, Malaysia.*

Sharma, H. K. (2015). Role of ICT in improving the excellence of education. *International Journal on Computer Science and Engineering*, *7*(8), 78.

Shyr, W. J., & Chen, C. H. (2018). Designing a technology-enhanced flipped learning.system to facilitate students' self-regulation and performance. *Journal of Computer Assisted Learning*, *34*(1), 53–62. https://doi.org/10.1111/jcal.12213

Singh, R. (2018). Exploring the utilization of technology in teaching English: Practices and impediments. *Journal of NELTA*, *23*(1–2), 153. https://doi.org/10.3126/nelta.v23i1-2.23360

Smith, T. E., Rama, P. S., & Helms, J. R. (2018). Teaching critical thinking in a GE class: A flipped model. *Thinking Skills and Creativity*, *28*, 73–83. https://doi.org/10.1016/j.tsc.2018.02.010

Song, Y., & Kong, S. C. (2017). RETRACTED: Affordances and constraints of BYOD (Bring Your Own Device) for learning and teaching in higher education:

Teachers' perspectives. *The Internet and Higher Education, 32*, 39–46. https://doi.org/10.1016/j.iheduc.2016.08.004

Spiteri, M., & Chang Rundgren, S. N. (2020). Literature review on the factors affecting primary teachers' use of digital technology. *Technology, Knowledge and Learning*, *25*(1), 115–128. https://doi.org/10.1007/s10758-018-9376-x

Stake, R. E. (2010). *Qualitative research: Studying how things work*. Guilford Press.

Suhendi, A. (2018). Constructivist learning theory: The contribution to foreign language learning and teaching. *KnE Social Sciences*, 87–95. https://doi.org/10.18502/kss.v3i4.1921

Suter, W. N. (2012). Qualitative data, analysis, and design. In W. N. Suter (Ed.), *Introduction to educational research: A critical thinking approach* (2nd ed., pp. 342–386). SAGE. https://doi.org/10.4135/9781483384443.n12

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. https://doi.org/10.29333/iji.2022.1517a

Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, *65*, 101565. https://doi.org/10.1016/j.techsoc.2021.101565

Tai, N. C. (2023). Applications of augmented reality and virtual reality on computer-assisted teaching for analytical sketching of architectural scene and construction. *Journal of Asian Architecture and Building Engineering*, *22*(3), 1664-1681. https://doi.org/10.1080/13467581.2022.2097241

Tan, C. S., Lau, X. S., Kung, Y. T., & Kailsan, R. A. L. (2019). Openness to experience enhances creativity: The mediating role of intrinsic motivation and the creative process engagement. *Journal of Creative Behavior*, *53*(1), 109–119. https://doi.org/10.1002/jocb.170

Tharayil, S., Borrego, M., Prince, M., Nguyen, K. A., Shekhar, P., Finelli, C. J., & Waters, C. (2018). Strategies to mitigate student resistance to active learning. *International Journal of STEM Education*, *5*(1), 1–16. https://doi.org/10.1186/s40594-018-0102-y

Tondeur, J., Forkosh-Baruch, A., Prestridge, S., Albion, P., & Edirisinghe, S. (2016). Responding to challenges in teacher professional development for ICT integration in education. *Educational Technology and Society*, *19*(3), 110–120. https://www.jstor.org/stable/jeductechsoci.19.3.110

Tran, T. B. L., Ho, T. N., Mackenzie, S. V., & Le, L. K. (2017). Developing assessment criteria of a lesson for creativity to promote teaching for creativity. *Thinking Skills and Creativity*, *25*, 10–26. https://doi.org/10.1016/j.tsc.2017.05.006

Tunjera, N. (2019). *Teacher educators' instructional strategies in preparing pre-service teachers to teach with digital technology in the 21st century.* [Doctoral dissertation]. Cape Peninsula University of Technology, Western Cape.

Tunjera, N., & Chigona, A. (2020, September). Assisting teacher educators with constructive technology integration into curriculum delivery in the 21st century. In *Proceedings of the Conference of the South African Institute of Computer Scientists and Information Technologists 2020* (pp. 12–18). Association for Computing Machinery.

Ugwu, C. I., Ekere, J. N., & Onoh, C. (2021). Research paradigms and methodological choices in the research process. *Journal of Applied Information Science and Technology*, *14*(2), 116–124.

Ugwu, N. P., & Nnaekwe, K. (2019). The concept and application of ICT to teaching/learning process. *International Research Journal of Mathematics, Engineering and IT*, *6*(2).

Utaminingsih, S., Machfud, S., & Kassymova, G. K. (2024). Development of learning management with animated video to increase motivation and learning outcomes. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *41*(2), 31-42. https://doi.org/10.37934/araset.41.2.3142

Van Hover, S., & Hicks, D. (2017). Social constructivism and student learning in social studies. In M. McGlinn Manfra, & C. M. Bolick (Eds.), *The Wiley handbook of social studies research* (pp. 270–286). John Wiley & Sons. https://doi.org/10.1002/9781118768747.ch12

Van Merriënboer, J. J., & Kirschner, P. A. (2017). *Ten steps to complex learning: A systematic approach to four-component instructional design*. Routledge. https://doi.org/10.4324/9781315113210

Veerasinghan, K., Balakrishnan, B., Ibrahim, M., Damanhuri, M., & Gengatharan, K. (2021). Design thinking for creative teaching of chemistry. *Social Sciences*, *11*(3), 670–687. https://doi.org/10.6007/ijarbss/v11-i3/8979

Vigo Arrazola, B., & Soriano Bozalongo, J. (2015). Family involvement in creative teaching practices for all in small rural schools. *Ethnography and Education*, *10*(3), 325–339. https://doi.org/10.1080/17457823.2015.1050044

Vongkulluksn, V. W., Xie, K., & Bowman, M. A. (2018). The role of value on teachers' internalization of external barriers and externalization of personal beliefs for

classroom technology integration. *Computers & Education*, *118*, 70–81. https://doi.org/10.1016/j.compedu.2017.11.009

Vygotsky L. S. (1978). *Mind in society: The development of higher psychological processes (Vol. 86)*. Harvard University Press.

Wa-Mbaleka, S. (2019). The researcher as an instrument. In *Proceedings of the World Conference on Qualitative Research* (pp. 33–41). Springer, Cham.

Wheeler, S., Waite, S. J., & Bromfield, C. (2002). Promoting creative thinking through the use of ICT. *Journal of Computer Assisted Learning*, *18*(3), 367–378. https://doi.org/10.1046/j.0266-4909.2002.00247.x

Willermark, S. (2021). Teachers' technology-related knowledge for 21st century teaching. In H. Ulferts (Ed.), *Teaching as a knowledge profession: Studying pedagogical knowledge across education systems* (pp. 42–64). OECD Publishing. https://doi.org/10.1787/39f7744f-en

Wilson, S. (2020). *Research is ceremony: Indigenous research methods*. Fernwood Publishing.

Wu, L., Hsieh, P. J., & Wu, S. M. (2022). Developing effective e-learning environments through e-learning use mediating technology affordance and constructivist learning aspects for performance impacts: Moderator of learner involvement. *The Internet and Higher Education*, *55*, 100871. https://doi.org/10.1016/j.iheduc.2022.100871

Yuen, M. C., Koo, A. C., & Woods, P. C. (2018). Online video for self-directed learning in digital animation. *Turkish Online Journal of Educational Technology*, *17*(3), 91–103.

Yurtseven Avci, Z., O'Dwyer, L. M., & Lawson, J. (2020). Designing effective professional development for technology integration in schools. *Journal of*

Computer Assisted Learning, *36*(2), 160–177. https://doi.org/10.1111/jcal.12394

ANNEXURES

Annexure A: Ethical Clarence Certificate

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: **26 September 2022**

PROJECT NUMBER: **TREC/529/2022: PG**

PROJECT:

Title:	Developing technology teachers' creative teaching skills through the integration of educational technologies in honours programme in a South African University.
Researcher:	PB Nkosi
Supervisor:	Prof MS Ramaligela
Co-Supervisor/s:	N/A
School:	Education
Degree:	Phd in Technology Education

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-0310111-031**

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 the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

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

Finding solutions for Africa

Annexure B: Gatekeeper permission letter

University of Limpopo
Office of the Registrar
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 2407, Fax: (015) 268 3048, Email: Kwena.Masha@ul.ac.za/Retha.Balie@ul.ac.za

19 January 2023

Mr. PB Nkosi

Email: praygod.nkosi@ul.ac.za

Dear Mr. Nkosi

GATEKEEPER PERMISSION TO CONDUCT RESEARCH

TITLE: **DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES IN HONOURS PROGRAMME IN A SOUTH AFRICAN UNIVERISY**

Researcher:	**PB Nkosi**
Supervisor/s:	**Prof. MS Ramaligela**
Co-supervisor/s:	**N/A**
School:	**Education**
Degree:	**PhD in Technology Education**

Kindly be informed that Gatekeeper permission is granted to you to conduct research at the University of Limpopo entitled: **"Developing technology teachers' creative teaching skills through the integration of educational technologies in honours programme in a South African University".**

Regards,

PROF. JK MASHA
UNIVERSITY REGISTRAR

Cc. Prof. RJ Singh: Deputy Vice-Chancellor; Research, Innovation and Partnerships
Prof. RN Madadzhe: Deputy Vice-Chancellor: Teaching and Learning
Dr. T Mabila, Director: Research Development and Administration
Prof. D Maposa – Chairperson: Research and Ethics Committee
Ms M Hutamo – Assistant: Ethics Secretarist
Ms A Ngobe – TREC Secretariat

Finding solutions for Africa

Annexure C: Permission letter

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

Nkosi PB

P.O. Box 680
Uthokozani
1346

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: **" DEVELOPING TECHNOLOGY TEACHERS' CREATIVE TEACHING SKILLS THROUGH THE INTEGRATION OF EDUCATIONAL TECHNOLOGIES IN HONOURS PROGRAMME IN A SOUTH AFRICAN UNIVERSITY"**

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).

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

The heartland of Southern Africa-development is about people

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

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.

22/05/2023

Mashaba KM
DDG: CORPORATE SERVICES

Date

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

Annexure D: Participants' informed consent form

Researcher: Nkosi P. B. Date: _____

I volunteer to participate in a research project conducted by Mr Nkosi P.B. from the University of Limpopo. I understand that the project is designed to gather information for the research with the topic: ***"Developing Technology Teachers' Creative Teaching Skills through the Integration of Educational Technologies in Honours programme in a South African University"***

- The procedure envisages the possibility of inherent risks for the participants that may not be apparent at the initial stage.
- The Ethics Committee has given its approval that the individuals may be selected to participate in the study.
- The experimental protocol covering the extent, aims and methods of the research, has been explained to me.
- The protocol sets out the risks that may occur as well as possible discomfort for persons participating in the research. The protocol also sets out the possible benefits derivable from the research to the participants and others.
- I will be informed of any new information that may become available during the research that may impact my continued participation in the research.
- The protocol has indicated that the participants' identifying information will not be required, and there will be no unauthorised access to the research data.
- Any question that I may have regarding the research or related matters will be appropriately responded to by the researcher.
- Participation in this research is voluntary and participants can withdraw their participation at any stage.
- I indemnify the University of Limpopo and all persons involved with the above project from liability that may arise from my participation in the research.

Agreement to participate in the research:

I have read, or the researcher has read to me, the above information relating to the study. I have had an opportunity to ask questions and the answers have been to my satisfaction. Therefore, I voluntarily agree to participate in the study.

Participant's name: _____ Date: _____

Signature of consenting party: _____ Date: _____

Signature of the investigator: _____ Date: _____

Signature of witness: _____ Date: _____

Annexure E: Participants' informed consent form

Researcher: Nkosi P. B. Date: _____

I, as parent/guardian, grant the permission for my child to participate in a research project conducted by Mr P.B. Nkosi from the University of Limpopo. I understand that the project is designed to gather information for the research topic ***"*Developing Technology Teachers' Creative Teaching Skills through the Integration of Educational Technologies in Honours programme in a South African University*"***

- The research procedure may have some inherent risks which may not be known at the initial stage.
- The Ethics Committee has given its approval that the students may be selected to participate in the study.
- The experimental protocol covering the extent, aims and methods of research has been explained to me.
- The protocol sets out the risks that may occur as well as possible discomfort for persons participating in the research. The protocol also sets out the possible benefits derivable from the research to the participants and others.
- I will be informed of any new information that may become available during the research that may impact my continued participation in the research.
- The protocol has indicated that the participants' identifying information will not be required, and there will be no unauthorised access to the research data.
- Any question that I may have regarding the research or related matters will be appropriately responded to by the researcher.
- Participation in this research is voluntary and participants can withdraw their participation at any stage.
- I indemnify the University of Limpopo and all persons involved with the above project from liability that may arise from my participation in the research.

Agreement to participate in the research:

I have read, or the researcher has read to me, the above information relating to the study. I have had an opportunity to ask questions and the answers have been to my satisfaction. I therefore voluntarily agree to participate in the study.

Participant's name: _____ Date: _____

Signature of consenting party: _____ Date: _____

Signature of the investigator: _____ Date: _____

Signature of witness: _____ Date: _____

Annexure F: Pre-intervention semi-structured group interview

The central theme that will guide this interview may be found in the following question.

“What are the Technology teachers’ knowledge and understanding of various Educational Technologies and approaches used in designing and presenting creative lessons before training?”

1 Do you use any Educational Technologies when designing a creative lesson and activity?
2 Which Educational Technologies do you normally use when designing creative lessons and activities?
3 What factors do you consider when choosing Educational Technologies during the design of creative lessons and activities?
4 Does the Educational Technologies use during lesson or activity presentation promote the Interaction of Prior Knowledge?
5 Does the Educational Technologies use during lesson or activity presentation promote the Interaction of New Knowledge?
6 Does the Educational Technologies use during lesson or activity presentation promote the Construct of Own Knowledge?
7 What Creative Teaching strategies do you adopt that facilitate the integration of Educational Technologies during the presentation of lessons and activities to engage IPK, INK and COK)?

Annexure G: Post semi-structured group interview

The central theme that will guide this interview may be found in the following question.

“What are the Technology teachers’ knowledge and understanding of various Educational Technologies and approaches used in designing and presenting creative lessons after training?”

Did the lessons presented on the integration of Educational Technologies for Creative Teaching helped you with the know-how in identifying relevant Technology that you can used during a lesson planning/lesson presentation?

Have you learnt anything with regards to the identification and use of Educational Technologies for lesson designing and presentation?

Is the use of Educational Technologies in Creative Teaching of importance/value to the teaching and learning process?

For the integration of Educational Technologies are there any factors that influences the identifying of an Educational Technologies for designing and presentation of creative lesson?

Annexure H: Document analysis (lesson plan and activity)

The central theme that will guide the document analysis may be found in the following question.

Addressing "How do Technology teachers use Educational Technologies to design and present creative lessons and activities that encourage social constructivism approach?"

Section A (lesson plan)				
NO	Components	Yes	No	Researcher's comments
1.	Is the topic outlined?			
2.	Are the objectives outlined?			
3.	Activity available?			
4.	Is there an integration of Educational Technologies?			
5.	Is an assessment tusk(s) available?			
6.	Instructional strategies outlined for teaching and learning activities?			
7.	Does the integration of Educational Technologies cater for IPK in relation to the following? (Introduction & eliciting prior knowledge)			
7.1	Allow learners to interact with prior knowledge in a real-life context.			
7.2	Allow learners to interact with prior knowledge in a previous lesson			
7.3	Allow learners to interact with prior knowledge in a previous grade			
8.	Does the integration of Educational Technologies cater for INK in relation to the following? (Advance knowledge)			
8.1	To allow learners to interact with new knowledge in a real-life context			
8.2	To allow learners to actively exchange, debate and negotiate ideas within their groups in a way that increases learners' interest in learning			
8.3	To allow learners to apply themselves as they try to get clarifications and understand the concepts			
Section B (Activity)				
NO	Components	Yes	No	Researcher's comments
1.	Does the activity link with topic?			
2.	Does the activity link with objectives?			
3.	Does the activity promote active learning?			

4.	Does the activity promote collaborative learning?			
5.	Does the activity promote interactive learning?			
6.	Does the activity promote real-life context learning?			
7.	Does the activity through the integration of Educational Technologies cater for COK in relation to the following?			
7.1	Allows learners to display what they already know, and further build on new knowledge through design activities.			
7.2	Provide learners with a platform where they can appreciate and comprehend diverse interpretations, including those delivered through technological media, and to adopt such in arriving at their own interpretations of a phenomenon.			
7.3	Allows learners to creatively think and reflect more deeply and meaningfully so that they can assume ownership of their knowledge, rather than simply duplicating the teacher's knowledge.			

Annexure I: Observation schedule

The central theme that underlies the observation schedule may be found in the following question.

"How do Technology teachers use educational technology to design and present creative lessons that encourage social constructivism approach?"

Name of the School:		
Grade:		
Date:		
Topic:		
Categories	**Aspects to be observed**	**Researcher's Comments**
Lesson presentation	Does the teacher provide insights which extend beyond the classroom?	
	Does the teacher show the required level of understanding of the subject matter?	
	Does the teacher show flexibly taking into consideration learners' prior knowledge	
	Does the teacher make use of any technological tool to enhance the teaching and learning process?	
Class activities	To what extent do the activities promote interaction among learners?	
	To what extent does the presentation of lesson and activities promote Interaction of Prior Knowledge?	
	To what extent does the presentation of lesson and activities promote Interaction of New Knowledge?	
	To what extent does the presentation of lesson and activities promote the Construction of Own Knowledge?	
	To what extent do the activities encourage learners to appropriately choose technological tools that enhance the development of learning and creative thinking?	
Instruct.	Does the technique used keep learners inquisitive and when doing the activities?	

	Does the style of questioning encourage high order thinking?	
	Is the classroom management effective?	
	Is there any technological tool provided for the learners?	
Assessment	Is there sufficient coverage of the design process in the type of assessment provided for the learners?	
	What type of assessment is given to learners?	
	Does the assessment provided cater for learners' IPK, INK and COK?	
	Does the assessment provided for the learners encourage the use of technology?	

Annexure J: Semi-structured interview questions

The central theme that underlies the semi-structured interviews schedule may be found in the following question.

The interview addressed the question "What are teachers' perceptions on the impact of Educational Technologies and understand and development of Creative Teaching Skills?"

[Greetings and shake hands] My name is Bonginkosi Nkosi, a PhD candidate at the University of Limpopo. I am conducting research for my dissertation titled: ***"*Developing Technology Teachers' Creative Teaching Skills through the Integration of Educational Technologies in Honours programme in a South African University."*** The interview will elicit information from you as both a Technology teacher. It is my hope that your views will provide my research with very useful pieces of information.

The questions I will ask you will be centred on your profession, your current course of study and experiences as someone teaching technology as a subject. Kindly note that you have every right to refuse to take part in this interview and, should you feel uncomfortable during the process, you are allowed to withdraw from the interview. Lastly, feel free to ask questions where you need clarity about anything.

This interview should take about 45 minutes of your time. Are you able to spare some time to respond to the questions that I would like to ask?

1. Did the intervention program presented on Social Constructivism, and Educational Technologies helped you with the know-how to identify relevant technologies that can be used for lesson designing and lesson presentation?
2. Have you learnt anything with regards to the identification and use of Educational Technologies for lesson and activity designing and presentation?
3. Is the use of Educational Technologies for Creative Teaching of importance/value?
4. Did the sessions on lesson reflections assist on your development of Creative Teaching Skills?
5. Having presented series of lessons using Educational Technologies with an aim of developing Creative Teaching Skills, would you say this exercise was fruitful?

Closing

Well, it has been a pleasure finding out more about you. The information that has been elicited from you will be used purely for this study. I appreciate the time that you took for this interview, and I believe a reasonably sizable pieces of information for the study. Is there anything else you would like to say or is there any information that you feel should be excluded from the recording?

Would it be okay to call you if there is a need to ask more questions or follow up on the views you have expressed during this interview?

Thanks once again for your time and insights.

Annexure K: Editor's Letter

30 Acton Avenue
Helena Heights
Somerset West
7130
Cell: 082 8183277
searle.edit@gmail.com

9 October 2024

I, Lydia Searle, performed the copy edit for the thesis titled, "Developing Technology Teachers' Creative Teaching Skills Through the Integration of Educational Technologies in Honours Programme in a South African University" by Praygod Bonginkosi Nkosi.

Language and grammar issues were approached using the MSWord Review (Track Changes) function. Punctuation and layout issues were addressed according to the guidelines of the University of Limpopo.

The reference list and the citations were edited following the referencing and citation style of the *Publication Manual of the American Psychological Association*, Seventh Edition.

I am not accountable for any changes made to this document by the author or any other party subsequent to my edit.

Yours faithfully,

Lydia Searle
L Searle
Member: Professional Editors' Guild RSA (PEG)

Member: Academic and Non-Fiction Authors' Association of South Africa (ANFASA)