# ENHANCING THE USE OF TABLETS IN TEACHING GRADE R MATHEMATICS AMONG ECD PRE-SERVICE TEACHERS AT A TVET COLLEGE IN GAUTENG

**by**

**DUDUZILE PRETTY SIBANYONI**

**Student number: 220143625**

**Dissertation submitted for the degree.**

**MASTER'S IN EARLY CHILDHOOD EDUCATION**

**in the**

**FACULTY OF EDUCATION**

**at the**

**UNIVERSITY OF MPUMALANGA**

**Supervisor: Professor M. G. Mahlomaholo**

**Submission date: 31 January 2024**

**DECLARATION**

I, Duduzile Pretty Sibanyoni (Student no. 220143625), declare that the dissertation entitled ***"ENHANCING THE USE OF TABLETS IN TEACHING GRADE R MATHEMATICS AMONG ECD PRE-SERVICE TEACHERS AT A TVET COLLEGE IN GAUTENG"*** submitted for the degree of master's in early childhood in Education is my own work and that all the sources that have been used are indicated and are acknowledged by means of complete references.

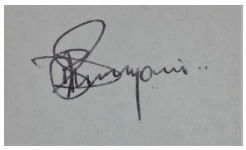
This dissertation contains no writing from other people unless it is explicitly identified as being sourced from other researchers. Where additional written sources are cited, then:

a. Their words have been rewritten, but the overall information that has been attributed to them has not been changed.
b. Their writing has been referenced, italicized, and enclosed in quote marks when their exact words have been used.

This dissertation does not contain text, graphics, or tables copied and pasted from the internet unless expressly acknowledged, and the source is detailed in the thesis and references section.

I further declare that I submitted the dissertation to originality-checking software, which falls within the accepted requirements for originality.

I further declare that I have not previously submitted this, or part of it, for examination at the University of Mpumalanga for another qualification or at any other higher education institution.



December 2023

DP Sibanyoni Date

## DEDICATION

This dissertation is dedicated to my father, Moses Sibanyoni; my late mother, Nomanzi Magdeline Sibanyoni; my late grandmother, Sophy Mahlangu; my daughters Zanokuhle & Sinokuhle; my niece, Melokuhle and *to all those who believed in me even when I did not believe in myself.*

**ACKNOWLEDGEMENTS**

I thank the Lord and my ancestors for giving me the strength to complete this dissertation.

Special thanks to the following people:

- To the co-researchers, my colleagues, and former colleagues, who participated fully and committed to this study.
- My daughters Zanokuhle and Sinokuhle: Thank you for believing in me and always motivating me to soldier on; if it was not for you, I would not have made it.
- My father, Moses Sibanyoni, my brother, Sthembiso Sibanyoni, my cousins and the whole family, Thank you for the support, *ngithokoza angicedi.*
- Prof. M.G. Mahlomaholo: Thank you for your guidance, motivation, and support throughout my study; your patience has brought me this far.
- The Department of Higher Education and Training (DHET) and The Gauteng Department of Education for granting me permission to conduct the study.
- My friend Delina Seolwana: Thank you for being there for me; words cannot express how thankful I am for all the support and motivation.
- My study partners, Nomfundo Skhosana, Gugu Yende, Ms. Manaka and Mr. Makgakga, for the encouragement, support, and team spirit.
- Dr Masalesa, Thank you for your guidance.
- Last, but not least my editor Carmen, thank you so much for all your hard and good work, I really appreciate.

## ABSTRACT

This study aims to design a strategy for enhancing the use of tablets in teaching Grade R mathematics among Early Childhood Development (ECD) pre-service teachers at a TVET college in Gauteng. The study adopted the posthumanism theoretical framework. According to Valera (2014:481), posthumanism is a total contamination and hybridization of human beings with other living beings and technological machines. In addition, posthumanism is not structured as the only appropriate philosophical reflection but as a form of narrative that originates from specific requirements, which are primarily human and disclose its deep anthropogenic roots. Furthermore, posthumanism questions the exceptionalism of humankind's foundation of the role of humans that is constructed in modernity (Bayne, 2018:1). The study focuses on designing a strategy for enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college. It explores the challenges that pre-service teachers experience when teaching Grade R mathematics using tablets. The challenges included but were not limited to limited disciplinary learning in mathematics using tablets, lack of Morden Pedagogical Learning in teaching mathematics, Inadequate Work-Integrated Learning (WIL), fundamental learning (the ability to use Information and Communication Technologies in teaching Mathematics) and challenges in Situational learning (general classroom management when using tablets to teach mathematics). Technological Pedagogical Content Knowledge (TPACK) was used as a conceptual Framework. The study further employed Participatory Action Research (PAR) as a methodological approach that involved all stakeholders within the community and was suitable because it is transformation-orientated and grounded in an emancipatory agenda. The research team identified the challenges experienced by the pre-service teachers in enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers; through discussions and reflections, the team came up with solutions and strategies that could assist pre-service in enhancing the use of tablets when teaching mathematics to realise their objectives. Critical Discourse Analysis (CDA) was used to analyse the data generated. CDA is one of the analytical research approaches that critically analyses speech. The findings have revealed that pre-service teachers have gained in-depth content knowledge and are now confident to deliver lessons using technological devices, including tablets. They are also able to balance between the

traditional methods and the new ways of teaching. This study further recommends that the NCV curriculum be broadened and more relevant to the industry.

**KEYWORDS:** Pre-service teachers, Tablets, TVET, Technological Pedagogical Content Knowledge (TPACK), Participatory Action Research (PAR), ECD.

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATION/ACRONYMS

| | |
|---|---|
| CAPS | Curriculum and Assessment Policy Statement. |
| CDA | Critical Discourse Analysis |
| CK | Content Knowledge |
| CMT | Campus Management Team |
| DBE | Department of Basic Education |
| DHET | Department of Higher Education and Training |
| DoE | Department of Education |
| ECD | Early Childhood Development |
| FCDA | Feminist Critical Discourse Analysis |
| HoD | Head of Department |
| ICT(s) | Information and Communication Technologies |
| MRTEQ | Minimum Requirements for Teacher Education Qualifications |
| NCTM | National Council of Teachers of Mathematics |
| NCV | National Certificate: Vocational |
| NQF | National Qualifications Framework |
| PAR | Participatory Action Research |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| TK | Technological Knowledge |
| TPACK | Technological Pedagogical Content Knowledge |
| TVET | Technical and Vocational Education and Training |
| WIL | Work-Integrated Learning |

# CHAPTER 1
# INTRODUCTION AND OVERVIEW OF THE STUDY

## 1.1 INTRODUCTION

This chapter introduces the topics that this study explores. The study's background is given the justification for the research, the problem statement, the goals, the significance of the study, the theoretical framework, an overview of the research design and methods, ethical concerns, the definition of the key concepts, and it concludes with a summary.

## 1.2 BACKGROUND

This study formulates a strategy to enhance the effective use of tablets in teaching Grade R mathematics among Education and Childhood Development (ECD) pre-service teachers at a Technical and Vocational Education and Training (TVET) college in Gauteng. In Turkey, Kenya, and South Africa, enhancing the use of technology is defined as using interactive technology in the form of educational apps as part of a play-based learning experience to improve learners' cognitive and problem-solving skills. Tablets are technological tools that allow handwriting functionality, web browsing, running software and a range of Apps. The Grade R curriculum was first outlined in the Revised National Curriculum Statement R-9 (2002) as part of the Foundation Phase Curriculum. In Turkey, Kenya and South Africa, the Grade R mathematics curriculum focuses on numbers, digital skills, reading, writing, measurements, oral, space and shape, data handling, geometry, patterns, functions, and algebra (Akturk et al., 2017; Republic of Kenya, 2017:10; DBE, 2011:10-11). TVET colleges offer relevant skills to pre-service teachers registered for education and development-related courses. Therefore, based on the above-mentioned, this study looks at how to enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college.

Several challenges may hinder the effective use of tablets in teaching Grade R mathematics. In most countries, including Turkey, Kenya and South Africa, resistance to change has been seen as a measured challenge, and teachers are comfortable with their traditional ways of teaching (Onyema, 2019:356). Research claims that many

ECD teachers struggle to adapt to modern and innovative pedagogical approaches because of their beliefs (Peterson et al., 2018). The literature indicates that teachers' perceptions and technological abilities usually influence the incorporation of technology into teaching and learning. However, teachers' beliefs often impede their practical use of Information and Communication Technology (ICT) in the classroom (Agegbo & Aina, 2021), teachers' convictions about the importance of ICT are relevant in pedagogical reasoning for teachers (Harris et al., 2017; Webb &. Cox, 2004). In Kenya, teachers experience challenges with the unavailability of clear policies that govern the ICT component in schools (Piper, Jepkemi, Kwayumba & Kibukho, 2015). Therefore, it is argued that when teachers consider emerging technologies useless for teaching, learning, and playing in a preschool environment, they become reluctant and unable to use them effectively for learning in the classroom (Nikolopoulou & Gialamas, 2015). This study seeks to highlight the challenges among pre-service teachers when enhancing the usage of tablets in teaching Grade R mathematics.

There are several ways in which the challenges have been mitigated. Various continuous professional development programmes for ECD and inclusive education in OECD countries had a positive impact. These types of continuous professional development programmes allow lifelong learning practices to be disseminated so that the information reaches teachers and key stakeholders. Professional development programmes in early childhood classes enable teachers to learn from each other through observation and demonstration of lessons and attend workshops (Henry et al., 2018). Henry et al. (2018) continued by saying the success of continuous professional development programmes hinges on effective supervision and monitoring of what goes on in schools by the officials in the education sector, school principals, and heads of department. While the District Education team has mechanisms in place for schools to engage in continuous professional development for ECD teachers, there is a need for all stakeholders to support the schools. School management teams should, therefore, continuously inform the District Education Team of challenges faced in implementing in-service programmes so that other stakeholders can be reached. In the study conducted by Omolo et al. (2017), it was found that student-teachers were able to practice the use of technology in the teaching of mathematics after learning from their tutors; it is therefore, it is vital to enhance the use of technology in the early

stages of their training at college. Studies suggest that teachers are willing to apply technology in their teaching after going through training sessions.

To effectively enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers' incorporating it into their training is necessary (Henry et al. (2018). Evidence shows that teachers' efficiency can be increased using digital equipment and resources to prepare for teaching. There is also evidence that digital tools and resources enable teachers to do their job better concerning teaching, assessment, and their own development. This study is necessary because there are conducive factors that assist with the strategy described above that need attention and implementation.

Integrating tablets in the classroom for teaching and learning is complex, and one may encounter several threats. Researchers and educators have used different categories to classify the problems in the use of ICT in educational institutions, and several studies have divided the issues into extrinsic and intrinsic categories. Ertmer (2019:34) referred to extrinsic problems as first-order and cited access, time, support, resources and training and intrinsic problems as second order and cited attitude, beliefs, practices, and resistance. In contrast, Hendren (2018) saw extrinsic problems in institutions rather than individual intrinsic problems per teachers, administrators, and individuals. Learners must be constantly supervised because they can access inappropriate content or information. If the proper security measures are not implemented, we cannot entirely rely on website blockers and internet filters all the time.

Enhancing the use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college is necessary because it prepares them for practical use and implementation. Furthermore, explicit guidance for child engagement and teacher training on best using instructional procedures during shared online activities is needed (Neuman, 2018). Parent and teacher beliefs surrounding new technologies can influence how children engage, interact, and learn about these digital devices and their world (Marsh, 2017; Paiva et al., 2017). The findings of the study conducted in 2017 suggested that tablets are popular tools that engage young children in play and enable them to gain positive learning experiences, skills and knowledge at home and school, supported by previous research (Marsh, 2016; Merchant, 2015) showing that tablets can be helpful learning tools for young children who, as competent operators,

use them for various purposes. Some teachers who are optimistic about tablet use in the classroom shared concerns about overusing tablets at home. There is a need to address these concerns if tablets continue to be used in educational contexts (Cathy, 2018). This study seeks to identify effective ways of enhancing the use of tablets to teach Grade R mathematics among TVET college pre-service teachers, find solutions to the challenges and identify threats that might hinder the successful implementation. It seeks to find that the solutions to the problems will indeed work.

## 1.3 PROBLEM STATEMENT

The current generation of pre-service teachers are digital natives; it is, therefore, essential to train and support them in using technology effectively in the teaching and learning environment. According to Jojo (2019:1), teaching mathematics in our schools is vital because it provides learners with basic principles of life that are applied in their daily lives; however, teaching mathematics in South African schools remains a challenge. According to Agyei and Voogt (2017:4322), most learners do not have the required mathematical problem-solving skills; hence, teaching mathematics in South African schools is pronounced the worst in the world. As a result, this study proposes enhancing the use of tablets in teaching Grade R mathematics among Education and Childhood Development (ECD) pre-service teachers at a TVET college in Gauteng. Technological tools such as tablets are increasing in schools; however, using such devices requires modified pedagogical approaches. Studies show that teachers feel they were not well prepared by their pre-service training programs to effectively implement technology in their classrooms (Pholotho & Mtsweni, 2016). Furthermore, studies indicate the importance of providing professional development for teachers to effectively use technology in their teaching space (Pholotho & Mtsweni, 2016). Specifically, mathematics teachers need to be trained in using technology to enhance learning, not only how the devices work.

More research still needs to be conducted on this subject; hence, this study aims to formulate a strategy to effectively enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers.

## 1.4 RESEARCH QUESTION

The main research question is:

*How can tablets be enhanced in teaching Grade R mathematics among ECD pre-service teachers at TVET College?*

## 1.5 THE AIM OF THE STUDY

The study aims to formulate a strategy for ECD pre-service teachers to use tablets to enhance teaching Grade R mathematics.

## 1.6 THE OBJECTIVES OF THE STUDY

The following objectives clarified the study to operationalise the aim:

i. To investigate the challenges that hinder using tablets for teaching Grade R mathematics among ECD pre-service teachers at a TVET college.
ii. To explore the possible solutions to the mentioned challenges.
iii. To investigate conducive conditions for those solutions.
iv. To anticipate possible threats to the emerging strategy and to mitigate them.
v. To establish possible suggestions that can propose effective strategies.

## 1.7 THEORETICAL FRAMEWORK

The theoretical framework that guides this study is posthumanism. According to Valera (2014:481), posthumanism is a total contamination and hybridization of human beings with other living beings and technological machines. In addition, posthumanism is not structured as the only appropriate philosophical reflection but as a form of narrative that originates from specific requirements, which are primarily human and disclose its deep anthropogenic roots. Furthermore, posthumanism questions the exceptionalism of humankind's foundation of the role of humans constructed in modernity (Bayne, 2018:1).

Posthumanism is relevant for this study because it defines technology as one of the many practical means to reach a not purely technology end by embracing the

symbiotic relationship between technology and humans (Valera, 2014:486). This study focuses on enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college in Gauteng.

Posthumanism is a progressive elimination and fluidization of existing differences (Braidotti, 2013). In addition, posthumanism represents the vertex of a parabola that began before the modern age, to which man is nothing but one of the living creatures inhabiting the Earth (Valera, 2014:483).

## 1.8 CONCEPTUAL FRAMEWORK

The conceptual framework that guides this study is the Technological Pedagogical Content Knowledge (TPACK). Mishra and Koehler (2012) defined TPACK as a teacher knowledge framework for technology integration and stated that it promotes effective teaching in the classroom context. According to Hechter, Phyfe and Vermette (2012:39, 136), TPACK is a pedagogical model that constructs the theoretical and practical components to design the learning process that is based on the teachers' and learners prior experiences (perceptions, beliefs, attitudes) using technological tools. TPACK contributes to the learning process by considering learners' needs and learning pace (Cheng et al., 2022:3).

TPACK is relevant for this study because it encourages pre-service teachers to be creative and active in the teaching and learning space and to improve their engagement with technology in their classrooms (Cheng et al., 2022:5). Cheng further explains that the TPACK model underlines the alignment among ICT instruments, content goals and outcomes, and selected pedagogy; thus, the emphasis on ICT integration practice determines teachers' knowledge on technology integration.

The TPACK framework focuses on integrating ICT and highlights the importance of identifying the need to empower teachers with skills when teaching with technology.

## 1.9 LITERATURE REVIEW

This study aims to contribute to the body of knowledge by designing a strategy to enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college. This section also reviews the literature on improving the

use of tablets in teaching mathematics among pre-service teachers, the challenges experienced, and designing the strategy to teach mathematics effectively using tablets.

Mathematics stimulates problem-solving skills in young children; these skills are easily visible when technology is being used in class (Kaushik, 2019:20). Theory and research have proven that the educational apps that are installed on tablets improve learning, reading and math knowledge for learners (Elgersma, 2018). The technological tools are more effective when the teachers understand that these gadgets are not meant to replace the teacher but are meant to make teaching and learning more fruitful with the proper guidance from the teacher (NAEYC, 2012:2). Furthermore, it is crucial to equip pre-service teachers with in-depth content knowledge and relevant pedagogical skills when preparing them for Work Integrated Learning (teaching practice).

Since the study employed Participatory Action Research (PAR) methodology, Critical Discourse Analysis (CDA) was used for data analysis. The critical issue in this study is to enhance the use of tablets in teaching mathematics among ECD pre-service teachers. The pre-service teachers need to be trained in Technological Knowledge (TK) not only to focus on Content Knowledge (CK) (Mishra & Koehler, 2006) but also to understand and meet the demands of the digital sphere.

## 1.10 RESEARCH DESIGN AND METHODOLOGY

This study has social repercussions that affect the lives of those involved and creates a close relationship between researchers and co-researchers. Hence, PAR is a suitable methodology to formulate a strategy to enhance the use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college in Gauteng. PAR is termed as a dynamic educative process, an approach to social investigation and an approach to taking action to address a problem (MacDonald, 2012:36). PAR is defined as an epistemological framework that consists of structured ways of knowing in the pursuit of worthwhile human purposes to foster action for social justice (Galletta & Torre, 2019:1). PAR is being considered as an alternative approach to traditional social or scientific research, as it moves social inquiry from a linear cause and effect

perspective to a participatory framework that considers the contexts of people's lives (MacDonald, 2012:36).

PAR is relevant for this study because its primary purpose is to create an environment that will empower people and improve the quality of livelihoods, which is the same case of this study (Balakrishna & Claiborne, 2017:186). This study uses PAR because it anticipates the possibility of improving the lives of participants involved in the research and the fact that it enables the participants to recognize their capabilities and create a drive towards self-sufficiency (Nelson, 2017:7). Furthermore, PAR is chosen for this study because it encourages the participants to be active throughout the study. PAR investigates the actual practices rather than the abstract practices of learning that involve actual, material, concrete practices of particular people in particular places (Dube, 2020:141). This study aims to formulate a strategy that will improve the enhancement of the usage of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college in Gauteng; the strategy will be formulated together with the people involved, referred to as the co-researchers following the principles of PAR.

Planning for change, implementing, watching the process unfold and its effects, reflecting on the processes and its effects, and finally re-planning all result in reflective cycles (Wamunga & Wakhu, 2021:150). PAR is cyclical; it moves through multiple stages of planning, acting, observing, and reflecting rather than adopting a conventional linear model of research (Walter, 2009:3). PAR is also spiral until one achieves or solves the problem. PAR enables collaborative knowledge and creation (Morales, 2016:159).

The participants in the study were the ECD pre-service teachers, pre-service teachers from the nearby university, teachers, lecturers, education specialists, learners, and parents. Pre-service teachers were allowed to prepare and present lessons in mathematics using tablets. Thus, the purpose of PAR in this study is to offer practical solutions to the pre-service teachers' concerns about being able to teach mathematics using technological tools.

The current study employed PAR because it encourages the active participation of participants during the research process, which empowers them and improves their

circumstances in their contexts. All participants were encouraged to openly share their thoughts, ideas, and views regarding the research project course using PAR.

### 1.10.1 The research site.

The research site for this study is a TVET college in the Gauteng province. It is a public college, formerly known as an FET college, operating under the auspices of the Department of Higher Education and Training (DHET) in terms of the Continuing Education and Training Act, Act No 16 of 2006, as amended. The College is accredited by Umalusi and several Sector Education and Training Authorities (SETA's) to offer education and training, mainly in the FET band (NQF Level 2 to 4). Some programmes are provided in the Higher Education band, i.e. N4 to N6 levels. With over 30,000 enrolments, the college is one of the biggest in the country.

The other site that will be used for this study is the primary school, which is not very far from the college where most ECD students go for their teaching practice. Though the school is also situated in the Gauteng Province, it is in the rural side of the province, where most of the students in the college come from. The school has 1084 learners from Grades R-7. The location of the College and the school is conducive to using PAR because all participants will be easily accessible and fully participate in the study.

### 1.10.2 Gaining entry

I wrote letters to the principal of the college, the campus manager, the Head of Department (HoD), the Education Specialist (ES) of the ECD programme, the principal of the school, the Department of Education (DoE) and the circuit to request permission to conduct research. I also sent letters to the identified team members asking them to participate in the study and to the parents of the learners involved to request them to allow their children to participate. The problem under investigation will be explained in the letter, and their rights will be highlighted. The team will select a study coordinator who will coordinate all the study activities and a scriber to take the minutes of the meetings and invite members for meetings throughout the study.

The research team wrote letters to the college's principal, parents, and the circuit requesting permission to conduct research at the TVET college and the school. The principal researcher wrote letters to the identified team members asking them to participate in the study. A letter requesting consent was sent to parents to allow their children to participate in the study, and learners, in turn, signed a letter of consent to be part of the study. Parents were invited to a briefing session about the study and to get a full explanation of the letters issued in the language of their choice. Their rights were explained during the meeting; the team and study coordinators were identified to coordinate the activities of the study, as well as scribers to take minutes and to invite members for meetings.

### 1.10.3 Research team.

The research team was identified and established through negotiations with the Campus Management Team (CMT), the Education Specialists, the HoD, and the mathematics team, which will assist in identifying the team different stakeholders involved in the study. The research team comprised the campus manager, HoD for National Certificate: Vocational (NCV), the Education Specialist for Mathematics, the Education Specialist for Education and Development, the foundation phase HoD, the Grade R class teachers, the ECD pre-service and the IT technician. The college and school librarians assisted learners and students with connecting to the internet. The focus will be on pre-service teachers based on how they effectively deliver a fruitful mathematics lesson using tablets in teaching Grade R learners. The pre-service teachers were observed while teaching, and videos and photos were taken. Observation notes were transcribed, followed by the meetings to discuss the teaching strategies and skills observed. The research team monitored the proceedings of the whole process during data generation.

## 1.11 METHOD FOR GENERATING DATA

A series of meeting sessions were held to produce the data. Meetings were held with different co-researchers at different times. For example, there was a meeting with the pre-service teachers where I explained the purpose of the study. Minutes were taken and kept for all meetings, and the attendance registers were used.

A strategic plan was formulated to identify priorities, responsibilities, and related actions, stating frames and resources for each activity to guide and monitor the data generation process. The research process was organized into phases from September 2022 to October 2023. A SWOT analysis highlighting the opportunities, threats, weaknesses, and strengths (SWOT) was used to generate data. Our SWOT analysis meeting was also recorded. Co-researchers were asked to use the video option when they spoke. Videos were taken during the presentation of lessons, and all the above were done in adherence with the ethical guidance by always obtaining consent from co-researchers.

### 1.11.1 Common vision and mission

Since compelling visions unleash four fundamental organizational forces—attracting commitment and energizing people, establishing a standard of excellence, and connecting the present with the future—they are an effective instrument for transforming practice (Martin et al., 2014:11). Teaching mathematics using tablets by pre-service teachers effectively is a goal-oriented strategy that fosters a shared sense of purpose for the team. A vision is intended to convey where an organisation is heading. Thus, the coordinated team and all stakeholders work toward achieving clarity on a problem's complexity and nature by unifying efforts.

### 1.11.2 SWOT analysis and action plan

A SWOT analysis evaluates the strengths, weaknesses, opportunities, and threats to obtain data. Finding proper solutions and answers and identifying threats that may hinder the successful implementation of effective mathematics teaching using tablets are attainable using a SWOT analysis. Initial planning meetings and our SWOT analysis meetings were also recorded. The researcher and co-researchers in attendance brainstormed about different strategic actions, e.g., challenges identified, a team norm to be developed, and an action plan. SWOT analyses enable us to prioritise aspects that need to be analysed.

## 1.12 DATA ANALYSIS

The data generated was analysed using CDA. CDA enables the identification of how power is represented in the language used and the processes by which language (re)produces and maintains social practices and privileges specific ways of doing, thinking, and being over others (Dandar & Lacey, 2021:6). CDA focuses on reviewing and analysing transcribed and verbal texts to disclose the discursive bases of power, inequality, dominance, and bias (Teele et al., 2020:109). According to Leotti, Sugrue, and Winges-Yanez (2021:6), CDA has four stages: Identification of a social problem, identification of obstacles towards addressing the social issue, considering whether the social problem serves a broader purpose and identification of possibilities to solve the social situation. Data was analysed from videos, pictures, recordings of the meetings, discussions, and notes taken (Teele et al., 2020:109).

This study used CDA to analyse, interpret, and explain how dominance and inequality were performed through text and talk (Mceleli, 2019:195). Fairleigh (1995) created a three-level model of CDA analysis, which incorporates discourse practice—text production and text interpretation—and language text— spoken or written—to ensure practical policy analysis. Using Fairleigh's dimensions of discourse analysis (Fairleigh, 1995), the text (description), and discourse practice (interpretation and the sociocultural practice), the data for this study were analysed using photographs, video recordings, filming, audio recordings, learners' scripts, core searchers' reflections, and lesson plans (Magunje & Chigona, 2021:89).

## 1.13 ETHICAL CONSIDERATIONS

Ethical considerations are deemed to be an integral part of research. Since this study involved ECD pre-service teachers at a TVET college, learners, teachers, lecturers, and parents, the researcher was subjected to ethical research considerations. The ECD pre-service teachers are registered at a TVET college in Gauteng; therefore, this research complied with the Department of Higher Education and Training and the Gauteng Department of Education`s ethical policy. In this research, I have considered the rights and feelings of co-researchers. The researcher used PAR as the preferred research design, where the co-researchers were fully involved in the research process. The researcher treated everyone with respect and clarified the research's

purpose. Consent and assent were requested from all co-researchers to ensure their respect and justice. When planning and conducting this research, the researcher considered gender roles, ethnicity, ability, age, sexual orientation, language, and other differences. I also ensured that research was conducted honestly concerning children's rights, cultural diversity, and human rights. The Protection of Personal Information Act (or POPI Act) (RSA, 2021), which protects your personal information, came into effect in July 2021. All participants' traditions, religious convictions, and practices are considered by (POPIA).

The Children's Rights Act (Children's Amendment Bill B18-2020 (RSA, 2020) was also considered as this study involved children. The name of the college and the school at which the research was conducted could not be explicitly mentioned. The research was conducted inside the classroom where teaching and learning occurred.

## 1.14 VALUE OF THE STUDY

Enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers is a challenge. This study is critical because it offers strategies to improve the use of tablets in teaching Grade R mathematics among ECD pre-service teachers. Hopefully, this study will be helpful to the pre-service teachers, lecturers, parents, and ESs. It was envisaged that this study would provide a guideline to the education sector (policymakers) to enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers. This study would benefit the TVET sector, ESs, policymakers, and program developers by developing quality material and online tools and training pre-service teachers to teach and think of digitising all the teaching material and tools.

## 1.15 RELEVANCE OF THE STUDY

The study is relevant to the enhancement of the use of tablets in teaching Grade R mathematics mong ECD pre-service teachers at a TVET college. The study may assist in teaching mathematics using tablets effectively and encourage some better ways of teaching mathematics to reach success. The study is relevant for guiding and preparing pre-service teachers and learners to solve problems, think critically, and work collaboratively and creatively in a digital and information-driven world (Brown,

Neal & Fine, 2011:21). Digital and ICT skills are essential. They must be applied and transferred to solve daily mathematical problems, recognise possibilities, and equip learners for meaningful and successful living in an evolving world. Hence, the research emphasises the importance of learning and teaching mathematics (Hu, 2022:11).

## 1.16 CHAPTER OUTLINE

This study has five chapters with the following layout. The main topic of Chapter 1 is the introduction, background, problem statement, research question, aim, and study objectives. Chapter 2 outlines the theoretical framework, conceptual framework, practical principles, and relevant literature in the literature review. Chapter 3 presents the research strategy and methodology and explains how the data was analysed. CDA is discussed in Chapter 4, along with the data processing, presentation, and interpretation results. The study's conclusions, a summary of the results, and recommendations are stated in Chapter 5.

***Table 1.1: Study plan***

| RESEARCH ACTIVITY | TIME IN MONTHS |
|---|---|
| 1. Submission of Research Proposal | October 2022 |
| 2. Chapter 1 (Introduction and Background) | November 2022 |
| 3. Chapter 2 (Literature review) | March 2023 |
| 4. Chapter 3 (Data generation) | April 2023 |
| 5. Chapter 4 (Data analysis) | July 2023 |
| 6. Chapter 5 Recommendations and Conclusion. | August 2023 |
| 7. Finalization of the first draft | September 2023 |
| 8. Submission for Examination | December 2023 |

## 1.17 CONCLUSION

The study's background, problem statement, purpose, theoretical framework, and literature review, which give the study's background and research methodology, were introduced in this chapter. The study's motivation was stated, the critical concepts were

defined and explained, and the value and ethical considerations were outlined. The objective of this study was to increase the body of empirical data on enhancing the use of tablets among ECD pre-service teachers at a TVET college. Lastly, the chapter outline was presented. It is important to conduct similar studies to increase empirical evidence regarding enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college.

# CHAPTER 2
# THEORETICAL AND CONCEPTUAL FRAMEWORK, PRACTICAL PRINCIPLES AND LITERATURE REVIEW

## 2.1 INTRODUCTION

This study aimed to design a strategy to enhance the effective use of tablets in teaching Grade R mathematics among Education and Childhood Development (ECD) pre-service teachers at a TVET college in Gauteng. This chapter presents the theoretical framework, namely, posthumanism, and discusses the conceptual framework, namely TPACK, that directs the study. This chapter traces the historical origin of posthumanism, its objectives, the different formats, the role of the researcher and the relationship with co-researchers. The related literature was further studied and organized, following the study objectives to formulate a strategy to enhance the effective use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college. This chapter focuses on the in-depth relationality with the challenges, the solutions to the challenges, the threats and conducive factors were explored, and an effective way of implementing the strategy was identified.

## 2.2 THEORETICAL FRAMEWORK

The theoretical framework identifies the researcher's world views and outlines the assumptions and preconceptions about the areas in the study (Green, 2014:35). It is a set of concepts and principles that provides a general understanding of a particular phenomenon or aspect of the world. It helps explain and predict the behavior and characteristics of that phenomenon and provides a structure for organizing and analyzing related data. It further helps the researcher to ensure that the research process is coherent and guides the selection of relevant methodologies to achieve the research aims (Green, 2014:35). This section focuses on posthumanism as an appropriate theoretical framework for this study. It considers and argues for the choice of posthumanism based on the historical background, objectives, formats, ontology, epistemology and the relationship between the researcher and the co-researchers. Therefore, the study follows and uses the posthumanism theory to demonstrate the study's objectives by identifying the components of the solutions to the challenges.

### 2.2.1 The Historical Origins of Posthumanism

Posthumanism is usually assimilated into philosophical approaches focusing on science and technology's latest developments (Ferrando, 2014:170) because “posthuman” is used as an umbrella term to accommodate numerous perspectives and different movements (Ferrando, 2013). Posthumanism originated in the nineties from the reflection of feminists, and it is nurtured by studies of the differences (Ferrado, 2014:169). Posthumanism is viewed as a condition that is already accessible based on humanistic and anthropocentric premises. Posthumanism deconstructs any ontological hierarchy (Ferrado, 2014:170). Posthumanism concerns itself with theoretical philosophy and applied ethics. More extensively, posthumanism can be seen as a path of knowledge, which may eventually result in complete awareness.

According to Valera (2014:481), posthumanism is a total contamination and hybridization of human beings with other living beings and technological machines. In addition, posthumanism is not structured as the only appropriate philosophical reflection but as a form of narrative that originates from specific requirements, which are primarily human and disclose its deep anthropogenic roots. Furthermore, posthumanism questions the exceptionalism of humankind's foundation of the role of humans constructed in modernity (Bayne, 2018:1).

Posthumanism is “a philosophical movement critical of the foundational assumptions of classical humanism that structure so much of life as we know, live and understand it” (Letts & Sandlin, 2013). Its early naming was in 1977 by Ihab Hassan. Hassan declared that five hundred years of humanism may be coming to an end as humanism transforms itself into something that we must helplessly call posthumanism (Hassan, 1977:843). Braidotti suggests that now is the time to think beyond rationality, self-regulation, and the definition of self in opposition to ‘other’; this is caused by “humanism’s restricted notion of what counts as the human is one of the keys to understanding how we got to a post-human turn at all” (Bayne, 2018:1; Braidotti, 2013).

Posthumanism involves us in making an ontological shift from understanding ‘the human’ as an entity that separates from the world and observant of the world and its (human and non-human) inhabitants to one which is connected to the world and only conceivable as emergent with and through it.

Posthumanism is characterized by gradually removing and fluidising existing distinctions (Braidotti, 2013). Moreover, it signifies the culmination of a trajectory that predates the modern era, wherein humans are viewed as just one among many living beings inhabiting the Earth (Valera, 2014:483).

### 2.2.2 Objectives of Posthumanism

Posthumanism is a transformative research theoretical framework that decanters the human subject in favour of affectivity and relationality; the researcher does not impose knowledge but respects the knowledge of the researched while regarding them as partners and co-researchers that can advance the knowledge gap (Kruger, 2016:85). Posthumanism allows the opportunity to focus on how humans are already constituted through the nonhuman (Kruger, 2016:86). Posthumanism allows experimenting with transversal research practices. Transversal research practices draw a range of fields, to name a few: critical theory, feminism, postcolonialism and cultural studies (Kruger, 2016:87). Posthumanism challenges one to let go of an ethics grounded in universal humanism when conducting research and to move towards intrinsic and relational ethics (Kruger, 2016:88). Guided by the posthumanism lens, the strategy intends to create a dialogic environment whereby ECD pre-service teachers may self-emancipate in terms of enhancing the use of tablets in teaching Grade R mathematics.

Posthumanism is a philosophy that critiques the traditional human-centered view of the world and calls for a more inclusive and holistic approach that considers the perspectives and experiences of non-human entities. In education, posthumanism can be used to argue for a shift away from traditional forms of teaching and learning that prioritize human knowledge and ways of knowing and towards a more inclusive and diverse approach that recognizes the value of non-human forms of intelligence and learning.

According to Yan et al. (2020), Posthumanism is mostly about rethinking human and nonhuman relations by challenging anthropocentric thinking. Posthuman pedagogy challenges traditional teaching methods and the relationship between the learner and what learners learn. Therefore, intra-action is suggested to resolve such a challenge (Yan et al., 2020:2314). In intra-action, the pre-existence of entities is not assumed (Posta, 2016), and learners are not defined by the pre-subscribed characters and

abilities that the learner identity is usually associated with. The pedagogy practice that embraces posthumanism should understand that learners can also produce knowledge rather than just knowledge consumers (Yan et al., 2020:2314; Murris, 2017).

Posthumanism gives modern ways of perceiving humans, including teachers and learners, as non-exceptional and entwined with other beings (Blaikie et al., 2020:1). Posthumanism's fundamental idea of "entanglement" (UNESCO, 2020; Cielemecka & Diagle, 2019; Alaimo, 2016; Bennett, 2010; Coole & Frost, 2010; Barad, 2007) refers to a combination of entities and beings that are also part of different combinations. In posthumanism, learners are viewed as "entangled" with, linked with, responsible for themselves and connected to, together with, the life habitats of all humans, non-humans, the planet, the environment, and space, including entities beyond the planet (Blaikie et al., 2020:3).

Posthumanism challenges researchers to interrogate and dismantle the humanist structures that numerous education systems rest upon (Blaikie et al., 2020:3). Posthumanism considers all participants, including learners and teachers, as creators of knowledge. Learners are no longer put in an inferior position (Moss, 2016), aligned to, and restricted by nature. Posthumanism moves away from seeing the "child as a deficit" (Murris, 2018), which considers learners limited and not yet knowledgeable. Still, it emphasizes that all humans, including teachers, are responsible for supporting learners (children) in becoming full participants in the world (Blaikie et al., 2020:4). The posthumanism approach encourages participants to be attentive and creative in the learning space.

The posthumanism approach in education includes rethinking pedagogy, knowledge production and dissemination (Blaikie et al., 2020:2). Posthumanism encourages change and the way we value ourselves, the planet, other species and beyond (Blaikie et al., 2020:2). Posthumanism approach needs us to think about the system, rather than thinking about it as an isolated independent entity. We must value all agents and their relationality (Blaikie et al., 2020:2).

### 2.2.3 Justification for the Posthumanism theory approach

Posthumanism is an appropriate theoretical framework that informs this study. This theoretical framework emphasizes the importance of considering the implications of technological advancements for education. It is based on the idea that as technology evolves, it will significantly impact human existence and how we learn. Posthumanism critiques the traditional human-centred view of the world and calls for a more inclusive and holistic approach that considers the perspectives and experiences of non-human entities (Blaikie et al., 2020:5). Posthumanism helps to break down the anthropocentric biases that have been long present in education. Posthumanism theory aims at enhancing the learning relationalities of the marginalized (Qhosola & Mahlomaholo, 2022:61). Therefore, this justifies my adoption of this paradigm as it promotes social justice and gives hope to the marginalised (Tsotetsi, 2014:29). Posthumanism emphasizes the importance of the relationship between human and technology, it argues that the incorporation of technology in learning is necessary. Technology is seen as an extension of human abilities and not a replacement. The current generation of pre-service teachers are digital natives. Therefore, training and supporting them in effectively incorporating technology in the teaching and learning environment is essential.

The posthumanism theoretical framework is based on the idea that our existence as humans is closely interdependent with that of non-humans, including technologies (Braidotti, 2013), which necessitated the introduction of a rational epistemology (Law, 1994), which sees knowing as a base of mutual reciprocity among different things (Bruzzone, 2021:58). The basic theory of a relational epistemology is that the knowing subject and the object of knowledge are not isolated but mutually entangled in a process of becoming with (Haraway, 2008). Another critical factor of posthumanism is that it can help to promote more holistic and interdisciplinary forms of learning. Traditional education often prioritizes disciplinary knowledge over interdisciplinary understanding, but posthumanism emphasizes the importance of understanding the connections and relationships between different fields of study. This can help to promote a more holistic and integrative approach to learning that is better suited to preparing learners for the complex and interconnected world they will encounter in future. Posthumanism is not a monolithic position, but it embraces a variety of approaches and sensibilities (Bruzzone, 2021:58).

## 2.3 DEFINITION AND DISCUSSIONS OF OPERATIONAL CONCEPTS

This section aims to define and discuss the operational concepts underpinning this study. Technological Pedagogical Content Knowledge (TPACK) will be discussed and contextualized among ECD pre-service teachers at a TVET college in Gauteng to develop a strategy to enhance the use of tablets in teaching Grade R mathematics.

### 2.3.1 Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2012) defined TPACK as a teacher knowledge framework for technology integration and stated that it promotes effective teaching in the classroom context. According to Hechter et al. (2012:39, 136), TPACK is a pedagogical model that constructs the theoretical and practical components to design the learning process based on the teachers' and learners' prior experiences (perceptions, beliefs, attitudes) using technological tools. TPACK contributes to the learning process by considering learners' needs and pace of learning (Cheng et al., 2022:3). TPACK includes technological knowledge, pedagogical knowledge, and content knowledge, which result in effective use of technology in education when blended.

The TPACK framework originates from Lee Shulman's construct of Pedagogical Content Knowledge (PCK) to include technology. In 1986 Shulman stated that the usual idea of knowledge in teaching is that teachers have a set of content knowledge – specific knowledge about the subject they are teaching- and a set of pedagogical knowledge – knowledge of how to teach including specific teaching methods (Santos & Castro, 2021:1). TPACK framework builds on Shulman's (1986; 1987) descriptions of PCK to describe the understanding of educational technologies by educators and PCK work together to produce effective ways of teaching with technology (Koehler & Mishra, 2009:62). In the 21st-century technology has a vital role as it is used as a tool that assists educators in the delivery of lessons and assist learners in the learning process.

McGraw-Hill (2019) stated that the theoretical framework of technological pedagogical content knowledge (TPACK) has been developed to clarify and explain the set of knowledge that needs to be taught by teachers and to teach effectively using technology. TPACK plays a crucial role the pre-service teachers since they are the future educators who are expected to mould the new generation (Santos & Castro,

2021:2). Several studies have shown that the application of TPACK in the classroom still needs to be given focus to ensure that the delivery of lessons is effective. Little attention has been given to the knowledge that teachers need to foster early literacy through technology and that education lecturers struggle with effectively using technology in their courses (Santos & Castro, 2021:2; Voogt & McKenney, 2016). In a study, teachers reported that training helped them improve their TPACK. However, some were concerned with the usefulness of pedagogical and content knowledge (Santos & Castro, 2021:2; Kurt, 2018).

Koehler and Mishra (2009) also mentioned that the TPACK theoretical framework is built on the seven elements and describes the seven areas of teacher knowledge that serve as the heart of good teaching.

1. ***Pedagogical Knowledge (PK)*** refers to teaching methods and processes, including knowledge in classroom management, assessment, lesson plan development, and learner learning.
2. ***Technology Knowledge (TK)*** refers to the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as desktop computers, internet connection, laptops, monitors for projection/television, printer, projector, scanner, speaker, tablet, etc.
3. ***Content Knowledge (CK)*** is the knowledge about the actual subject matter to be learned or taught. Teachers must know about the content they will teach and how the nature of knowledge differs for various content areas.
4. ***Pedagogical Content Knowledge (PCK)*** refers to the content knowledge that deals with the teaching process. Pedagogical content knowledge is different for various content areas, as it blends content and pedagogy intending to develop better teaching practices in the content areas.
5. ***Technological Pedagogical Knowledge (TPK***) refers to how various technologies can be used in teaching and understanding that using technology may change how teachers teach.
6. ***Technological Content Knowledge (TCK)*** refers to the knowledge of how technology can create new representations for specific content. It suggests that teachers understand that using a particular technology can change how learners practice and understand concepts in a specific content area.

7. ***Technological Pedagogical Content Knowledge (TPACK)*** refers to the knowledge teachers require to integrate technology into their teaching in any content area. Teachers intuitively understand the complex interplay between the three essential components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies.

This model (see Figure 2.1) has three main components of teachers' knowledge: Content, Pedagogy and Technology. Equally crucial to the model are the interactions between and among these bodies of knowledge, represented as PCK (Pedagogical Content Knowledge), TCK (Technological Content Knowledge), TPK (Technological Pedagogical Knowledge) and TPACK.

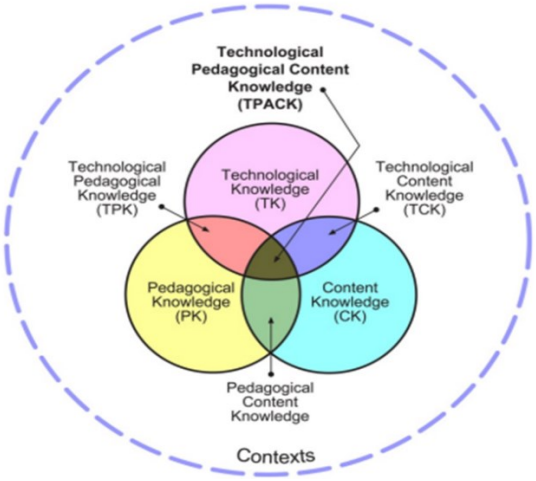



***Figure 2.1: Revised version of the TPACK (Mishra, 2019:77)***

The TPACK framework is also defined as a complex interaction among three bodies of knowledge: content, pedagogy, and technology. The interaction of these bodies of knowledge, both practically and theoretically, produces the knowledge that is needed to integrate technology use into teaching successfully (Koehler & Mishra, 2009:60). Teachers teach in complex and dynamic environments that constantly require them to improve and evolve their teaching methods and broaden their understanding of subject matter (Koehler & Mishra, 2009:61). The strategy will focus on enhancing the TPACK model in teaching Grade R mathematics among ECD pre-service teachers.

#### *2.3.1.1 Pedagogical Content Knowledge (PCK)*

PCK is defined mainly by what Shulman (1986:7) called 'the missing paradigm' in teacher education as it incorporates the content knowledge and pedagogy on how to present topics to learners (Shulman, 1987:8). PCK specifically focuses on teaching and therefore, it differentiates subject teacher from subject expert (Kwong, Joseph, Eric & Khoh, 2007:28). Ibeawuchi (2010:12) argues that "mathematics educators differ from mathematicians not necessarily in quantity or quality of subject matter knowledge, but in how that knowledge is organised and used". Furthermore, a mathematician may not have the necessary skills to transform their content knowledge into forms that are pedagogically powerful and yet adaptive to the variations in ability and learners' background (Shuman, 1987:15). On the other hand, mathematics teachers can adapt mathematics subject matter knowledge for pedagogical purposes and deliver to learners (Marks, 1990:7).

Mathematics teachers play an important role in providing a conceptual understanding through PCK. However, research has shown that based on the recent literature, there is not enough evidence relating to the factors that could affect the PCK of teachers. It is important to strengthen the PCK level of mathematics teachers as well as pre-service teachers to boost their competence to bridge the gap (Sakaria, Maat & Matore, 2023:1). Sakaria et al. (2023:3) concluded that the PCK of mathematics teachers is influenced by three types of factors namely, individual, professional, and organisational. In the recent era of science and technology, mathematical content, attitudes, and abilities are crucial competencies for the effective teaching and learning of mathematics (Sakaria et al., 2023; Woldemichael, 2022; Moh'd et al., 2021). These competencies assist mathematics teachers in creating an environment conducive to teaching and learning and also allow the teachers to use effective methods (Sakaria et al., 2023:1).

After the introduction of the PCK model by Shulman in the 1980s, it has been often said that it is the primary knowledge used to determine unique ways of conducting fruitful, interactive, and practical lessons (Sakaria et al., 2023:1). Mathematics teachers demonstrate the application of mathematical knowledge through PCK to achieve desired outcomes. Teachers with high levels of PCK may combine their mathematical content knowledge with other teaching skills to provide holistic learning (Sakaria et al., 2023; Kristanto et al., 2020). According to Kristanto et al. (2020),

teachers with high PCK levels are likely to achieve better results in mathematics. Furthermore, Hoover et al. (2016) claimed that high competence in PCK of teachers can expand learning opportunities through planned activities. Therefore, it is essential to recognize the PCK level of mathematics teachers when looking at classroom competencies (Sakaria et al., 2023:1; Moh'd et al., 2021).

#### *2.3.1.2 Mathematics content knowledge*

One important factor in teaching and learning mathematics in the 21st century is to have a practical lesson that engages learners actively in the classroom (Anthony & Walshaw, 2009). Teachers and pre-service mathematics teachers must have adequate mathematics knowledge to develop a practical mathematics lesson. According to the National Council of Teachers of Mathematics (NCTM, 1991), mathematics content knowledge is described as: "The content and discourse of mathematics, including mathematical concepts and procedures and the connections among them; multiple representations of mathematical concepts and procedures; ways to reason mathematically, solve problems, and communicate mathematics effectively at different levels of formality" (NCTM,1991:132). Kilpatrick, Swafford, and Findell (2001) defined it as: "Knowledge of mathematical facts, concepts, procedures, and their relationships among them; knowledge of the ways that mathematical ideas can be represented; and the knowledge of mathematics as a discipline in particular, how mathematical knowledge is produced, the nature of discourse in mathematics, and the norms and standards of evidence that guide argument and proof" (Sakaria et al., 2023:37). Teachers with a solid mathematics content knowledge can present mathematics as a consistent and related structure (Leong et al., 2015:364).

#### *2.3.1.3 Knowledge of mathematics pedagogy*

Knowledge of mathematics pedagogy generally refers to the skill of teaching mathematics effectively. Pedagogical content knowledge consists of three components: knowledge of content, knowledge of the curriculum, and knowledge of teaching (Leong et al., 2015:364).

Teaching requires more than just a subject expertise (Shulman, 1986). According to Copur-Gencturk and Tolar (2022), pedagogical content knowledge is knowledge of learners' mathematical thinking and knowledge of mathematics teaching. Knowledge

of learners' mathematical thinking "includes an understanding of what makes the learning of specific concepts easy or difficult: the conceptions and preconceptions that learners of different ages and backgrounds bring with them to the learning" (Shulman, 1986:9). For example, if a teacher can identify the reason why the learner is struggling to understand certain mathematical concepts, it is an indication of teachers' knowledge of learners' knowledge of learners mathematical thinking. The second component, knowledge of mathematics teaching, circumscribes knowing "the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986:9). For example, being able to use another method or strategy when learners are unable to understand some mathematical concepts is an indication of the teacher's knowledge of mathematics teaching.

#### *2.3.1.4 Mathematics curriculum knowledge*

A curriculum is a sequence of guidelines consisting of teachers' educational aims to teach learners from when they start school in Grade R to the FET (Further Education and Training) phase. The curriculum is constituted by programs which are designed to teach a particular subject in one specific grade, including teaching and learning materials related to those programmes and topics (Shulman, 1986:10). Shulman (1987:8) defined curriculum knowledge as 'tools of the trade'. It is a toolbox consisting of material that teachers use when planning their lessons for a specific mathematics topic. This includes, but is not limited to, teaching resources, teaching aids, prescribed assessments, and stratagem to teach mathematics (Tunner-Bisset, 2001 cited in Van der Sandt, 2007:345). In short, curriculum knowledge is perceived as the ability to "make judgments about the mathematical quality of instructional materials and modifying as necessary" (Holmes, 2012:67). Consequently, teachers with solid curriculum knowledge can choose suitable methods to teach and manipulate curricula appropriately to meet the needs of all learners (Holmes, 2012:64; Ball & Cohen, 1996:6).

However, the teachers' choice of curriculum material is mainly influenced by their beliefs about what is important and how they view their learners (Ball & Cohen, 1996:6). Shulman (1986:10) divides curriculum knowledge into two categories, namely, lateral, and vertical curriculum knowledge. The lateral curriculum knowledge

is viewed as being familiar with curriculum material used by learners even in other subjects in the same grade and at the same time. In contrast, vertical curriculum knowledge involves understanding topics that have been and will be taught in the subject during the preceding and later years, respectively (Shulman, 1986:10). Hauk, Toney, Jackson, Nair & Tsay (2014:26) argue that vertical knowledge includes the understanding of the connective relationship of pre-requisite topics and potential future topics. They further stated that "curricular thinking is ways of thinking about (strategies, approaches to) mathematical topics, procedures, and concepts as well as the relationships among them" (Hauk et al., 2014:26). Other researchers further introduced a phenomenon called 'horizon knowledge' regarding curriculum knowledge (Hurrel, 2013:58; Loewenberg Ball, Thames & Phelps, 2008:403). Horizon knowledge is defined as the capacity to connect related mathematical topics over the curriculum span and "articulate how the mathematics you teach fits into the mathematics which comes later" (Hurrel, 2013:58). This kind of knowledge helps the teacher to have an understanding of what learners already know and what they still need to know to build a solid foundation for the concepts that they will encounter in future.

## 2.4 RELATED LITERATURE

Earlier, it was stated that this study aimed to design a strategy to enhance the effective use of tablets in teaching Grade R mathematics among Education and Childhood Development (ECD) pre-service teachers at a TVET college. This section reviews the literature on the challenges and strategies used in South Africa and other countries, internationally and in Africa, to determine lessons from best practices. The focus is to understand the contexts under which the TPACK framework can be used effectively to enhance the usage of tablets in teaching Grade R mathematics and how it could be implemented successfully. This section also looks at the anticipated threats to find ways to avoid them and indicators of success.

### 2.4.1 Challenges that hinder the effective use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college

This section discusses challenges critical to the effective use of tablets in teaching Grade R mathematics among TVET pre-service teachers.

#### *2.4.1.1 Limited disciplinary learning in mathematics using tablets.*

According to Palsa and Mertala (2022), disciplinary learning, also known as subject matter, in mathematics refers to the content, theories, concepts, principles, and skills that constitute the field of mathematics. Subject matter in mathematics also includes solving mathematical problems, mathematical reasoning, and applying mathematical concepts in real-world situations (Palsa & Mertala, 2022:227). Pre-service teachers must use teaching strategies and tools to enhance the learners' understanding and engagement with the subject.

In education, a tablet is a portable touchscreen device providing a digital platform for teaching and learning (Moreno, 2022:722). Tablets have become increasingly popular for teaching mathematics productively due to their versatility and interactive capabilities. Tablets offer access to various educational apps and games designed to introduce mathematics (Moreno, 2022:722). These apps often include interactive exercises, puzzles, and simulations that engage learners and make learning mathematics enjoyable and engaging.

In Turkey, research has shown that pre-service teachers have difficulty in teaching mathematical concepts using tablets because they don't have robust mathematical content (Evens, Elen & Depaepe, 2015:3). Research has also proven that the number of instruments that measure pre-service mathematical knowledge for teaching is minimal because mathematics education researchers only started to design such instruments at the beginning of the 21st century (Avcu, 2019:1). The curriculum taught in teacher education programs seem to be outdated and is not aligned with modern teaching methods (Avcu, 2019:1) The outdated curriculum hinders the pre-service teachers from enhancing the usage of tablets in teaching mathematics, which are essential for creating engaging and interactive math lessons, leaving pre-service teachers ill-equipped to teach the latest mathematical concepts and using modern strategies (Avcu, 2019:2).

In research conducted in Kenya, it was revealed that tablets might not always provide a comprehensive understanding of mathematical concepts, especially in complex topics; it is, therefore, essential to supplement the use of tablets with a deeper understanding of the mathematical content to ensure that learners have a holistic

understanding of mathematical concepts (Ishenyi et al., 2023:183-184). Furthermore, other studies have indicated that using tablets for teaching topics such as Numbers, Data Handling, Space, and Shape has fundamentally impacted teaching and learning. However, the lack of a deeper understanding of mathematical content hinders the effective use of tablets in mathematics (Abrahamson, 2017:11).

In South Africa, the poor performance of learners in mathematics has been associated with flawed instructional approaches that do not make sense and limited mathematical content that is taught to pre-service teachers during their training program (Siyepu & Vimbelo, 2021:1). According to Siyepu et al. (2018), pre-service teachers must be experts in experts in mathematics. They further suggested that pre-service teachers should be able to extract the content and interpret the curriculum recommended for the phases they specialise in (Siyepu & Vimbelo, 2021:3).

Siyepu and Vimbelo (2021) further elaborated that Grade R teachers lack conceptual understanding of mathematics and that pre-service and in-service teachers' limited knowledge of mathematical content and confidence in integrating tablets are of particular concern. Digital technologies can encourage more profound understanding and robust mathematical connections within the subject and its many applications.

In education, a tablet is a portable touchscreen device providing a digital platform for teaching and learning (Moreno, 2022:722). Tablets have become increasingly popular for teaching mathematics due to their versatility and interactive capabilities. Tablets offer access to various educational apps and games designed to teach mathematics (Moreno, 2022:722). These apps often include interactive exercises, puzzles, and simulations that engage learners and make learning mathematics enjoyable and engaging. For example, a game of numbers and objects can be used when teaching basic number operations. These apps can cover many mathematical concepts, from basic arithmetic to advanced topics like algebra and geometry. Tablets also consist of digital manipulatives such as virtual base-ten blocks, fraction bars and geometric shapes (Moreno, 2022:723). The inability to embrace these digital manipulatives might hinder learners from experimenting and visualising mathematical concepts interactively and dynamically. Embracing tablets in a mathematics classroom can encourage learners to develop a deeper understanding of abstract concepts and enhance problem-solving skills (Moreno, 2022:724).

Tablets serve specific educational and training goals that cannot be implemented with traditional educational methods (Abdulla, 2022:168). On the other hand, tablets have a long-term effect on learners' learning retention and help them develop their skills, knowledge, and experiences. Tablets enhance learning with pleasure by combining learning while playing and audio with video materials (Abdulla, 2022:170).

#### *2.4.1.2 Lack of modern pedagogical learning in teaching mathematics with tablets*

According to the Minimum Requirements for Teacher Education Qualifications (MRTEQ) Policy (2011), pedagogical learning is defined as general pedagogical knowledge, which includes learning, knowledge of learners, assessment strategies and curriculum. Pedagogical learning requires specified content knowledge, including presenting concepts, methods, and discipline strategies to create expanded learning opportunities for all learners and evaluate their progress (MRTEQ, 2011:8).

In the studies conducted in Turkey and Kenya, it was evident that the curriculum taught at TVET colleges is not relevant to the needs of the industry (Kirior, 2017:22). The study further stated that there is no connection with what is being taught during training and what pre-service teachers are expected to teach their learners. TVET pre-service teachers feel inferior when teaching during their teaching practice and beyond (Kirior, 2017:23). They also lack confidence in what they do (Government of Kenya, 2005), and this proves there is a need for TVET institutions to restore their identity by aligning their curriculum with industrial needs.

In South Africa, the NCV curriculum was criticised for its bureaucratic approach (Mgijima, 2021:14), as it was implemented without proper consultations with relevant stakeholders. There was no mechanism for monitoring the process (Powell, 2014:16). For example, pre-service teachers are taught only the common mathematical content in all programs available at TVET. They are not taught how to teach mathematics, which becomes challenging when they go for teaching practice. The component of pedagogical learning is being neglected (Mgijima, 2014:360). The Sector Skills Plan of the Education, Training and Development Practices Sector Education and Training Authority (ETDP SETA) in 2011 also highlighted concerns about lecturers' readiness for the implementation of the NCV curriculum (Sibisi, 2019:4).

Another challenge in the NCV curriculum mismatch is the limited training of pre-service teachers, particularly in teaching mathematics using technological tools such as tablets. While pre-service teachers may receive mathematical content knowledge, there seems to be a deficiency in preparing them to effectively enhance the use of tablets in teaching mathematics to learners. This deficiency becomes more evident during their teaching practice, as they usually struggle to apply modern learner-centred pedagogical learning, which encourages participation and active engagement, using different teaching strategies and resources, and fostering critical thinking and problem-solving abilities (Sibisi, 2019:4).

#### *2.4.1.3 Inadequate Work-Integrated Learning (WIL)*

Makgato and Moila (2019) state that providing quality TVET is vital in increasing productivity, empowering citizens, alleviating poverty, and promoting economic and socio-economic development. The TVET sector serves a dual purpose: to further education and serve the needs of the world of work.

TVET pre-service teachers refer to individuals enrolled in a TVET college for a National Vocational Certificate (NCV) in Education and Development L2-L4. The NCV programme is regarded as a high-skill, high-quality, and high-knowledge programme intended to respond directly to the priority skills and demands of the modern economy. The program consists of the theory component as well as the practical component. The theoretical knowledge is assessed through Internal Continuous Assessment (ICASS), and an Internal Summative Assessment Task (ISAT) is employed to assess the practical component. The student is also expected to acquire the WIL, usually done at primary schools and daycare centres.

Work Integrated Learning (WIL) refers to the practical learning and exposure students gain through engaging in real-world work environments as part of a structured educational program. It allows students to participate actively in professional settings, applying their knowledge and skills in practical work situations and gaining valuable insights and experience related to their field of study. The WIL component is an instrument used by the TVET sector to improve the quality of the training programme and give confidence to potential employers that students can do the work (Ngubane, Ntombela & Govender, 2020:5). According to the study conducted by Ngubane et al.

(2020), there's a shortage of host-employers in the geographical location of the campuses which makes it difficult for students to reach potential employers as they are far from where they stay. Furthermore, it was also noted that not all levels of the NCV programme get priority for the WBE, and that is against the principles underpinning the NCV curriculum, which clearly states that students must gain experience from local industries and local institutions to complete their programme (Ngubane et al., 2020:7). The increasing number of students in the TVET sector makes it more difficult for workplace exposure. Students' attitude towards the experience and the attitudes they encounter in the workplace is also concerning, especially where some employers feel that having students wastes time, forgetting that experience cannot be bought. Some employers treat logbooks as a paper exercise, thus indirectly making the whole experience irrelevant and a waste of time for students.

Allias et al. (2021) shared a similar view about the consequences of failing to manage students' attitudes and expectations, as learners' attitudes can have an enormous impact on the college's relationships with host employers. They further explained that other institutions do not value the presence of students. Students can easily be discouraged when the workplace does not provide the expected workplace experience. The consequence is negative attitudes and underperformance, which lead to employers' reluctance to host more students and possible withdrawal from the process.

WIL aims to give pre-service teachers expanded opportunities to enhance their tablet skills when teaching mathematics. Giving pre-service teachers adequate time for teaching practice will allow them to identify and address potential challenges and barriers that may arise when using tablets in the mathematics classroom (Ngubane et al., 2020:7). Furthermore, providing pre-service teachers with substantial teaching practice using tablets ensures that they are well-prepared to use technology effectively and creatively in their future classrooms (Moreno et al., 2022:724). This preparation benefits the teachers and enhances their prospective learners' learning outcomes and experiences.

In Turkey, pre-service teachers are expected to observe for at least three weeks during their first year (Mpu, Roy & Hackmack, 2022:19). Traditionally, teaching is perceived as a skills-based activity that requires the teacher to draw from different sources of

knowledge. A typical teacher preparation curriculum includes conceptual and contextual knowledge (Dreyer, 2015).

#### *2.4.1.4 Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics)*

The lack of ICT (Information and Communication Technology) by pre-service teachers refers to a situation where future educators are not adequately trained or prepared to incorporate technology into their teaching practices effectively. Pope et al. (2012) conceptualised using ICT practices as an opportunity for pre-service teachers to develop creative teaching methods. According to Chang et al. (2021), in Turkey, TVET lecturers hardly use technology like tablets when introducing pedagogical or content knowledge in their lessons. Furthermore, research has proven that the attitudes of TVET lecturers towards technological tools, especially tablets, influence pre-service teachers' confidence levels (Pope et al., 2022) as well as their attitudes towards the integration of ICT in their future instructional practice (Alsharief, 2018:43). Alsharief (2018) further stated that, as technology advances, it is important for pre-service teachers to be familiar with tablets and other ICT tools. However, suppose they don't get proper training from their lectures. In that case, they may feel overwhelmed or uncertain about incorporating technology into their lessons, resulting in limited or ineffective use of technology in teaching and learning.

In a study conducted in several TVET colleges, including Kenya and South Africa, fundamental learning has been defined as modern pedagogical learning, which refers to contemporary approaches and methodologies in education that leverage current technologies, research findings, and innovative teaching strategies to enhance the learning experience (Arfo, 2015:36). However, this component is lagging as it is not appropriately incorporated in the TVET curriculum. It does not receive the attention it deserves (Osumba et al., 2023:1). By integrating these ICT tools into mathematics education, teachers can cater to diverse learning styles, enhance understanding, and prepare students for the technologically driven challenges of the future. It's essential to provide guidance and support to ensure that technology enhances, rather than replaces, effective teaching strategies (Osumba et al., 2023:3). By addressing the lack of ICT usage by pre-service teachers, TVET colleges can ensure that teachers are

adequately prepared to leverage technology as a powerful tool for enhancing teaching and learning experiences in the 21st century (Osumba et al., 2023:16).

Addressing pre-service teachers' lack of ICT modelling requires a comprehensive approach involving teacher education programs, professional development opportunities, and policy changes. Teacher education programs should integrate ICT modelling and training as an essential component of their curriculum, equipping pre-service teachers with the necessary knowledge and skills to effectively leverage technology in their future classrooms. Additionally, continuous professional development should be provided to practising teachers to keep them updated with the latest technological advancements and pedagogical strategies.

Furthermore, educational institutions and policymakers should emphasize the importance of integrating technology into education and provide the necessary resources and support to facilitate this integration, including allocating funding for technology infrastructure, providing access to relevant software and hardware, and establishing policies that promote the responsible and effective use of technology in educational settings.

By addressing the lack of ICT modelling by pre-service teachers, we can ensure that teachers are adequately prepared to leverage technology as a powerful tool for enhancing teaching and learning experiences in the 21st century.

#### *2.4.1.5 Challenges in Situational learning (general classroom management when using tablets to teach mathematics)*

Situational learning refers to different types of learning situations, contexts, and environments of education, such as classrooms and communities, as well as to prevail policy, political and organizational contexts (MRTEQ, 2011:9). Situational learning also refers to a learning approach that emphasizes the context or situation in which learning occurs. It focuses on real-life experiences and encourages learners to apply their knowledge and skills in specific, authentic situations. Situational learning often involves problem-solving, critical thinking, and the practical application of concepts to address challenges or tasks relevant to a particular context.

In Turkey, formal education is considered as knowledge that is self-sufficient and decontextualized of the situations in which it is learned and used (Marquez, VinCent,

Marquez, Pennefather, J Smolkowski & Sprague, 2016:87). The main aim of schools and colleges is to transfer the theoretical knowledge, which includes primarily abstract and formal concepts. However, there is a considerable disconnect between the theory and the practical. Furthermore, in this information era, many researchers have discussed the separation of what is learned from how it is learned and used because experts and practitioners in real life treat and use skills and knowledge very differently from formal education settings (Marquez et al., 2016:87). Hence, pre-service teachers encounter problems in practising the knowledge and skills learned through formal learning to their daily lives and teaching practice (Marquez et al., 2016:87). Rather than the knowledge that is memorized, tested, and then forgotten, the knowledge used by pre-service teachers during teaching practice and beyond is more valuable. The instruction given in meaningful, contextualized learning environments may be more understandable and applicable in situations conducive to teaching and learning.

Kenya's education system has undergone various reforms, such as the Competency-Based Curriculum (CBC). The CBC strongly emphasises competency development, including practical and applied skills. Situational learning principles align well with the goals of competency-based education (Ochieng et al., 2023:464). There may be an increased focus on practical application and hands-on learning in subjects like mathematics, which can involve situational learning experiences where pre-service teachers engage with learners in activities based on real-life experiences (Ochieng et al., 2023:464). However, the teaching methods taught to pre-service teachers during their training program do not assist them when doing practical's because most of these teaching methods are teacher centred (Ochieng et al., 2023:465). The success of situational learning depends on the preparedness of teachers. Therefore, teacher training programs must focus on equipping pre-service teachers with the skills that will assist them in implementing situational learning strategies effectively during their teaching practice.

Like in Kenya, South Africa has also undergone curriculum reforms to address the changing needs of education. The Curriculum and Assessment Policy Statement (CAPS) emphasizes practical skills and applications. Situational learning principles need to align with these goals, emphasizing real-world problem-solving (Schotte, 2022:2). Considering the diverse cultural and economic landscape of South Africa, educational approaches, including situational learning, must be designed to be

culturally and contextually relevant. The scope of a learning experience for pre-service should be restructured to address the unique challenges and opportunities within the different communities the TVET colleges serve.

While the use of tablets in teaching mathematics may have numerous benefits, there are also challenges associated with their integration that pre-service teachers may experience in terms of classroom management.

### 2.4.2 Solutions to the challenges of effectively using tablets to teach mathematics.

This section briefly outlines the best practices in response to the challenges identified as crucial to successfully enhancing the use of tablets in teaching mathematics among pre-service teachers at a TVET college.

#### *2.4.2.1 The need for strengthening disciplinary learning in mathematics using tablets.*

Using technology to integrate tablets in teaching and learning mathematics can strengthen disciplinary learning. Pre-service teachers may use interactive mathematics apps and simulations that allow learners to explore mathematical concepts engagingly. Apps like GeoGebra or Desmos can help learners visualize and interact with mathematical ideas. Pre-service teacher programs must be structured in a way that they are not only taught mathematics but also need to be taught how to teach the subject using technological tools like tablets.

As part of teachers' competencies and skills provided by professional qualifications, pre-service teachers are expected to have in-depth knowledge of the subjects they specialise in (DBE, 2016: B-44). The National Development Plan (NDP) also advocates for teachers to have a sound knowledge of the subjects they teach, especially mathematics (NDP, 2013:303). The study conducted by Mji and Makgato (2006:206) revealed that SA mathematics teachers have challenges regarding mathematics content knowledge. Poor teacher training resulted in a significant content knowledge gap (Umugiraneza, Bansilal & North, 2017:72). Training institutions for pre-service teachers need to give them proper training to integrate tablets effectively into

their teaching practices. This includes strategies for managing technology in the classroom and utilizing educational apps.

When implementing these strategies, using tablets in mathematics is crucial to maintain a balance, ensuring that technology enhances learning without becoming a distraction. Additionally, ongoing assessment and feedback help tailor the use of tablets to meet the evolving needs of learners.

#### *2.4.2.2 The need to establish a subject committee for teaching mathematics using tablets.*

In an educational context, a subject committee is a group of teachers who come together to focus on a specific academic subject or discipline. These committees are formed within schools or educational institutions and are typically composed of teachers specialising in the subject area. The primary purpose of subject committees is to facilitate collaboration, professional development, and the improvement of teaching practices within a specific subject. The curriculum and assessment policy statement (CAPS) aims to produce individuals who can work effectively with others as team members (DBE, 2011:5).

Such subject committees provide a platform for teachers, pre-service teachers, lecturers, and education specialists to engage in ongoing professional development related to mathematics, which may involve workshops and training sessions to enhance teachers' knowledge and teaching skills. The Subject Committee worked to ensure that the curriculum for mathematics is aligned with educational standards and objectives. This involved reviewing and updating lesson plans, instructional materials, and assessment strategies.

Teachers within this subject committee shared resources such as textbooks, teaching aids, digital tools, and lesson plans. This collaborative sharing is essential because it enriches all members' teaching and learning experiences. Research suggests that a coordinated team needs many people to collaboratively plan to advance the learners' educational interests (Qhosola, 2016:57). Collaborative teaming is defined as "an ongoing process whereby teachers with different areas of expertise and experiences work together to address problems that are faced by learners and hinders their success" (Knackendoffel, 2007:1). Studies have shown that teachers' cooperation with

colleagues, reflection on educational practice and “provision of a supportive working environment that encourages collaboration may benefit pre-service teachers as well as in-service teachers’ PCK development” (Evens et al., 2015:2). Working together as a team gives teachers and pre-service teachers a platform to share problems and consequently get emancipated in their teaching practice (Mceleli, 2019:40).

#### *2.4.2.3 Self-efficacy for technology integration of tablets in mathematics*

Self-efficacy for technology integration by pre-service teachers in mathematics refers to the belief and confidence that these aspiring teachers have in their ability to effectively use technology tools and resources to enhance the teaching and learning of mathematics (Bakar, Maat & Rosli, 2020:259). It reflects their perception of their capabilities in utilizing technology to support learners' mathematical understanding, engagement, and achievement (Bakar et al., 2020:260).

Lestari and Indrasari (2019) defined self-efficacy for technology integration as an essential factor that influences teachers’ actual use, acceptance, or adoption of technology in teaching. It also refers to teachers’ confidence in their capabilities to incorporate technology into teaching to facilitate student learning successfully (Hur et al., 2015:17). Teachers with higher levels of technology integration self-efficacy are more open to new ideas, strategies, or experiments for incorporating technology to create learning opportunities and are more willing to put forth continuous efforts to tasks that involve the use of technology (Anderson & Maninger, 2007).

Pre-service teachers’ self-efficacy regarding mobile technology integration is highly related to their intention to adopt mobile devices in teaching (Menon et al., 2017; Burden & Hopkins, 2016; Hur et al., 2015). Hur et al. (2015) explored factors affecting pre-service teachers’ intention to use mobile devices for teaching through structural equation modelling (SEM). Self-efficacy for technology integration significantly influences the intention to use mobile devices directly and indirectly. Burden and Hopkins (2016) indicated the importance of self-efficacy for mobile technology adoption from their study examining pre-service teachers’ beliefs regarding using mobile technologies as a teaching or learning tool. Pre-service teachers with more exposure to various technologies in their education are likely to feel more confident using technology in their future classrooms (Burden et al., 2016:12).

Adequate training and professional development in technology integration can boost pre-service teachers' confidence in using technology effectively for teaching mathematics. Positive attitudes toward mathematics and technology also contribute to a greater belief in the potential of technology integration in teaching mathematics. Teacher preparation programs should consider providing hands-on experiences with technology, incorporating technology-rich coursework, offering relevant and practical professional development opportunities, and creating a positive and supportive learning environment that promotes technology as a valuable tool in mathematics instruction. Additionally, mentorship and role modelling by experienced educators can also play a crucial role in building pre-service teachers' confidence in using technology effectively in the mathematics classroom.

#### *2.4.2.4 Creating solid partnerships between TVET colleges and the industry*

Research findings proved that industry partnerships with TVET colleges and exposure to workplace-based training positively influence the employability of TVET graduates (UNESCO-UNEVOC, 2014). The TVET partnerships with industry have great potential to improve graduates' work-readiness (employability). Creating a solid partnership between TVET colleges and industry is crucial for both parties' success and the region's overall economic development. Such partnerships can bridge the gap between academic knowledge and practical skills required in the job market, leading to a more competent and job-ready workforce.

#### *2.4.2.5 Modifying the pre-service teachers' programme at TVET colleges*

The criteria that define qualified teachers have completely changed; they are no longer limited to a teacher's content-specific and pedagogical knowledge. Instead, they went beyond that to technological know-how (Alhawiti, 2018:14). This claim is consistent with Mishra and Koehler's (2006) assertion that teachers must grasp more than the subject area they teach; they must also have a deep understanding of how the application of technology can change the subject matter. Khateeb (2021) stated that most pre-service teachers are not adequately digitally competent, as they do not match the standards of good digital teachers required for the twenty-first century.

Alzahrani (2021) suggested that training on technological tools and how to use them represent a crucial demand that TVET colleges must provide to their students, particularly pre-service teachers. Nowadays, almost all teacher preparation programmes worldwide have technology training (Yüksel & Kavanoz, 2022). They at least provide one compulsory course in computer competency for undergraduate students. This approach would put new teachers in a better position than their predecessors. First, they would not have to change the teaching habits that they had built over a long period (Batane & Ngwako, 2021). Second, they would not have to face the difficulties and challenges their predecessors faced when they switched to digital education. Third, they would successfully create a rich learning environment and effective use of technology (Gibson, 2021:18)

Technology improves learners' achievement (Kaur, 2020:1) and assists them in accessing information, collaborating with others, communicating information, thinking creatively, expressing themselves, and constructing knowledge (Nath, 2022:12). Pre-service teachers may receive knowledge and skills of ICT; however, they seem unqualified to implement them in a classroom setting, it is therefore imperative for TVET colleges to amend the curriculum in a way that it will best prepare the students for the working environment (Liu, 2022:8).

#### *2.4.2.6 Aligning the NCV curriculum with the industry needs*

Redesigning the TVET colleges to meet global skills needs necessitated changes in teaching and learning approaches (Sibisi, 2019:10). Lecturers had to adapt by embracing new teaching methods, accommodating diverse student groups, and taking on additional responsibilities. While change can be uncomfortable initially, with time and support, lecturers can effectively implement the changes and contribute to a more responsive and relevant TVET curriculum.

Many developed countries, including Turkey, have recognized the importance of TVET and have tried to improve and align the curriculum to the needs of the industry. One of the key areas of focus has been the development of occupational standards, which serve as a foundation for designing learning outcomes for vocational education (Ayaz et al., 2021:459).

The development of occupational standards includes defining the knowledge, skills, and competencies required for a specific occupation. These occupational standards are designed in collaboration with industry experts, potential employers, and relevant stakeholders to ensure that the TVET curriculum is aligned with the needs of the labour market. By having well-defined occupational standards, the curriculum can be tailored to address the real-world requirements of different industries and enhance the employability of TVET graduates (Ayaz et al., 2021:459-460). Additionally, the curriculum reform in TVET aims to update the content and teaching methods of vocational education. The reform process considers changes in technology, industry practices, and the evolving job market to ensure that TVET programs remain relevant and responsive to current and future workforce needs. This process may involve introducing new courses, incorporating technology-related skills, and promoting hands-on learning experiences to bridge the gap between theory and practice (Ayaz et al., 2021:460).

## 2.5 CONDUCIVE CONDITIONS THAT ENSURE EFFECTIVE USE OF TABLETS TO TEACH MATHEMATICS AMONG TVET PRE-SERVICE TEACHERS

This section briefly discusses the conducive conditions and best practices in response to the problems that must be resolved for enhancing the use of tablets when teaching mathematics among TVET pre-service teachers.

### 2.5.1 Conducive conditions to strengthen disciplinary learning in mathematics using tablets.

Teachers must intuitively understand the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009:135). Conditions conducive for teachers applying content knowledge and pedagogical content knowledge. Pre-service teachers must be proficient in these three areas of knowledge and be able to combine their understanding of subject, pedagogy, and technology (Schmidt et al., 2009:135). These conducive conditions must be established to ensure the effective use of tablets to teach mathematics.

### 2.5.2 Conditions conducive to establishing a subject committee for teaching mathematics using tablets.

According to college chatter, Edward Everett Hale once philosophized: “Coming together is a beginning, keeping together is progress, working together is success” (Durban Girls College, 2018:1). From this statement, it is evident that the success of any team is rooted in working together. A team may create an environment where an individual may achieve what could not be achieved if working in isolation (Qhosola, 2016:54).

It is also stated that teamwork success depends on team members' readiness and willingness to support one another and make “it easier to provide input and solutions to the challenges” (Everson et al., 2018:1017). It is further postulated that when a team is established, team members must repeatedly work in cohesive groups to become acquainted with each “other’s preferences, personalities, strengths, and weaknesses” (Everson et al., 2018:1017). This view posits that when the team is newly established, the frequency of meetings is crucial to enable team members to familiarize themselves with the team routines.

### 2.5.3 Conditions conducive to self-efficacy for technology integration

Creating conditions conducive to self-efficacy for technology integration involves fostering an environment that empowers pre-service teachers to feel confident and capable of using technology in their teaching practices. Learning objectives related to technology integration must be clearly articulated. When pre-service teachers understand how technology enhances learning outcomes, they are likelier to develop a sense of efficacy. Continuous support and follow-up opportunities should be provided after initial training. Regular check-ins, workshops, and additional learning opportunities can reinforce skills and maintain pre-service teachers' confidence in using technology.

### 2.5.4 Conditions conducive to creating strong partnerships between TVET colleges and Industry.

Building strong partnerships between TVET colleges and industry is crucial for aligning education with the workforce's needs and ensuring that graduates are well-prepared for the demands of the job market.

### 2.5.5 Conditions conducive to modifying the pre-service teachers' programme at TVET colleges.

Modifying the pre-service teacher program at TVET colleges requires careful consideration of various conditions to ensure successful implementation. Ensure that modifications align with national standards and accreditation requirements for teacher education programs. Compliance with standards enhances the credibility and recognition of the pre-service teacher program.

### 2.5.6 Conditions conducive to aligning the NCV curriculum with the industry needs.

Aligning the National Certificate Vocational (NCV) curriculum with industry needs is crucial for ensuring that graduates are well-prepared for the demands of the workforce. Establish strong partnerships and collaboration with industry stakeholders. Engage potential employers, industry associations, and professionals to provide input on the skills and competencies required in the workforce (Ayaz et al., 2021:459-460). Ensuring that the NCV curriculum is aligned with national and international occupational standards. This alignment helps maintain consistency and credibility in the skills and knowledge imparted to students.

## 2.6 ANTICIPATED THREATS AND HOW TO CIRCUMVENT THEM WHEN USING TABLETS FOR TEACHING AND LEARNING MATHEMATICS

One may encounter several anticipated threats when using tablets for teaching and learning mathematics. It is essential to be aware of these threats and take proactive measures to circumvent them to ensure a successful implementation.

Tablets can be a source of distraction for learners, especially if they have access to non-educational apps or games. To circumvent this, pre-service teachers should implement clear rules and guidelines on tablet usage during mathematics lessons and use mobile device management (MDM) tools to restrict access to non-educational content during class time (Henry et al., 2018:23). Technical glitches, such as app malfunctions, battery drain, or internet connectivity problems, can disrupt the learning process. Teachers should perform regular maintenance on tablets, keep them charged, and have a backup plan in case of technical difficulties. They should also prepare alternative offline activities if internet access is temporarily unavailable (Hu, 2022:12).

Relying too heavily on tablets may lead to neglecting other important teaching methods. Pre-service teachers should be taught to balance tablet-based activities and other hands-on, collaborative, and interactive learning experiences. Some educational apps may not align perfectly with a particular school or region's curriculum or teaching approach. Pre-service teachers should be encouraged to customize and supplement tablet-based content to meet their learners' needs and align with the prescribed curriculum.

## 2.7 EVIDENCE OF A SUCCESSFUL CULTIVATION OF EFFECTIVE TEACHING OF MATHEMATICS USING TABLETS

In response to the challenges identified as essential to the successful teaching of mathematics using tablets among pre-service teachers at a TVET college, this section quickly presents evidence from the literature.

### 2.7.1 Disciplinary learning in mathematics

Research indicates that successful implementation of the effective teaching of mathematics using tablets among pre-service teachers at a TVET college is evidenced in many ways.

In Turkey, an increased learner participation and enthusiasm in mathematics class was experienced. Observations of heightened learner engagement during tablet-

based lessons increased the interaction with digital content and active participation in collaborative activities facilitated by tablets (Henry et al., 2018:23).

In Kenya and South Africa, improved academic performance and understanding of mathematical concepts were noted. Comparative analysis of learners' pre- and post-assessment scores demonstrated a positive impact on learning outcomes following the integration of tablets (Somuncu & Aslan, 2021:886). Using formative assessments and quizzes provided real-time data on learners' progress.

### 2.7.2 Subject committee for teaching mathematics using tablets.

The established subject committees for teaching mathematics provided a collaborative space for teachers to enhance their professional development, share resources, address challenges, and contribute to the continuous improvement of the process of teaching and learning mathematics. Subject committees have provided a platform for mathematics pre-service teachers to engage in collaborative learning. They also shared insights, strategies, and best practices, fostering continuous professional development and training.

### 2.7.3 Self-efficacy for technology integration in mathematics

Pre-service teachers with high self-efficacy in technology integration appeared more confident in using tablets to teach mathematics. This confidence has positively impacted their teaching practices and willingness to experiment with new teaching methods. Teachers with high self-efficacy contribute to a positive and supportive learning environment. Their confidence in technology integration can inspire enthusiasm among students and create a classroom culture that values using tablets for learning.

Teachers with high self-efficacy contributed to a positive and supportive learning environment. Their confidence in technology integration inspired learners' enthusiasm and created a classroom culture that values using tablets for teaching and learning.

### 2.7.4 Modifying the pre-service teachers' programme at TVET colleges

Modifying the pre-service teachers' program at TVET Colleges can create a more dynamic, relevant, and practical learning experience for pre-service teachers, ultimately benefiting the quality of education and the teaching profession. Modifying the program allowed for better alignment with current and future industry needs. Pre-service teachers can be equipped with skills and knowledge that directly match the requirements of the job market.

### 2.7.5 Aligning the NCV curriculum with the industry needs

Aligning the NCV curriculum with industry needs has facilitated a collaborative and dynamic approach involving continuous communication and feedback loops between teachers and industry stakeholders. The alignment ensured that pre-service teachers were well-prepared and equipped to meet the demands of the evolving workforce. Stay current with emerging technologies relevant to the industries associated with the NCV program. Integrate instruction on using industry-specific tools, software, and technologies into the curriculum.

## 2.8 CONCLUSION

Chapter 2 discusses the theoretical framework that guides the study, including operational concepts, the justification of the use of posthumanism, and the exploration of components of TPACK. The related literature is also reviewed. According to the literature review in this chapter, TVET pre-service teachers must enhance the use of tablets to teach Grade R mathematics. The literature review highlighted the challenges, solutions to the challenges, threats that might hinder the integration, conducive factors and indicators of success in ensuring that tablets are used effectively for teaching and learning.

# CHAPTER 3
# RESEARCH DESIGN AND METHODOLOGY

## 3.1 INTRODUCTION

The study aims to formulate a strategy to effectively enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college in Gauteng. The research design and methods, as well as details on how the obtained data were analysed, are described in this chapter. PAR was employed because the study includes social repercussions that impact the lives of those involved and fosters close relationships between researchers and participants. PAR recognises participants as co-researchers who are dynamic human beings. PAR is a form of action research that entails the researcher and participants working together to change the situation (Dlamini, 2018:89). This chapter also contains comprehensive information on the criteria used in participant selection as well as participant profiles like how PAR is adopted, it is based on an emancipatory agenda. It is transformation-oriented (Nhlapho, 2021:25).

## 3.2 RELEVANCE OF PAR AS AN APPROACH

PAR is relevant for this study because its primary purpose is to create an environment that will empower people and improve the quality of livelihoods, which is the same case of this study (Balakrishna & Claiborne, 2017:186). This study uses PAR because it anticipates the possibility of improving the lives of co-researchers and the fact that it enables the people involved to recognize their capabilities and create a drive towards self-sufficiency (Nelson, 2017:7). Furthermore, PAR is chosen for this study. After all, it encourages the participants to be active throughout the study. PAR investigates the actual practices rather than the abstract practices of learning that involve actual, material, concrete practices of particular people in particular places (Dube, 2020:141). This study aims to formulate a strategy that will improve the enhancement of the usage of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college in Gauteng; the strategy will be formulated together with the people involved, referred to as the co-researchers following the principles of PAR.

### 3.2.1 The historical origin of Participatory Action Research (PAR)

PAR was introduced in the late 1960s and early 1970s as a research methodology and approach to address social and political issues, particularly those affecting socially disadvantaged and marginalized communities (Rosetti et al., 2022:27). The origin of PAR can be traced back to the works of scholars like Kurt Lewin, who emphasized the significance of involving co-researchers in the research process. PAR is characterized by its emphasis on collaboration, empowerment, and active participation of the people or communities being studied. It also involves a cyclical process of reflection, action, and research, where co-researchers collectively identify problems, act, and reflect on the outcomes to inform further action (Raynor, 2019:130). PAR is a research approach that prioritizes the involvement of those directly impacted by a problem in the research process. PAR is based on the belief that those directly affected by a problem or issue are best equipped to understand it and propose effective solutions. It seeks to empower co-researchers to engage in the research process actively.

In PAR, the researcher takes on a facilitator role rather than a controlling role. The researcher does not impose a predetermined agenda or solutions but collaborates with co-researchers to identify relevant research questions and methodologies. The needs and perspectives of the participants drive the research topic and design. The main goal is to address pertinent and significant issues to the community or individuals involved.

PAR values the first-hand knowledge and experiences of co-researchers and actively involves them in all stages of the research, from problem identification to action planning and evaluation. PAR recognizes that co-researchers can learn valuable information while actively engaging in research. This experiential learning can foster unexpected creativity and insights that may not have been apparent through traditional research approaches (Raynor, 2019:131). PAR is a dynamic and inclusive approach that seeks to address social problems and promote positive change through collaboration, shared learning, and the active involvement of those most affected by the studied issues.

### 3.2.2 Objectives of Participatory Action Research (PAR)

One of the central objectives of PAR is to empower individuals and communities involved in the study. According to Teele, Nkoane and Mahlomaholo (2020:108), PAR aims to give a voice to marginalised people. Through active participation in the research process, co-researchers gain a sense of empowerment and ownership over the issues they are addressing. PAR seeks to promote social change and address social inequalities and injustices; it also aims to identify and address the root causes of problems rather than just addressing symptoms (Teele, 2020:108). Furthermore, the goal of PAR is to create positive, sustainable societal changes (Teele, 2020:108).

PAR aims to generate new knowledge and insights by drawing on the experiences, perspectives, and expertise of co-researchers. It recognizes that those directly impacted by a problem often possess unique knowledge that can inform effective solutions. PAR often includes capacity-building elements to enhance participants' skills, capabilities, and leadership. Through the research process, those involved can learn new skills in research, problem-solving, and advocacy (Raynor, 2019:131). PAR fosters collaboration and community building. It encourages individuals and groups to work together towards reaching a common goal. This collaborative approach can strengthen social bonds and networks within communities.

PAR strengthen networks and social bonds within communities by encouraging individuals and groups to work together towards achieving a common goal. PAR promotes participatory decision-making processes. It aims to ensure that decisions about research priorities, actions, and solutions are made collectively, with the input of all stakeholders (Teele, 2020:108). PAR emphasises ethical considerations, ensuring research is conducted respectfully, culturally sensitively, and ethically. As stated, another objective for PAR is to contribute positively to the lives of those involved, and PAR aims to develop a deep contextual understanding of the issues being studied. This understanding is grounded in the lived experiences of co-researchers, and it can lead to more effective and contextually relevant solutions. This study aimed to develop a strategy to enhance the use of tablets in teaching Grade R mathematics among pre-service teachers.

### 3.2.3 Formats of Participatory Action Research (PAR)

PAR is regarded as a powerful tool for improving the educational experience of learners involved in the research process. By actively involving all stakeholders, respecting their expertise, and working collaboratively, PAR can lead to more inclusive and effective educational practices that benefit everyone involved in the research process. While there is no one-size-fits-all format, PAR can take various formats depending on the specific context and goals of the research. In PAR, all members have equal power, and their opinions and knowledge are equally respected. They collaborate to achieve set objectives and actively seek solutions (Johnson & Flynn, 2021:7). The co-researchers in this study collaborated to develop a strategy to enhance the use of tablets in teaching Grade R mathematics among pre-service teachers.

### 3.2.4 Steps and stages in Participatory Action Research (PAR)

The steps and stages of PAR emphasize collaboration, empowerment, and the active involvement of participants in every aspect of the research and action process. The cyclical nature of PAR allows for ongoing learning, adaptation, and the development of a deeper understanding of complex issues. The stages of PAR are planning and problem diagnosis, action stage, observation, and reflection stage. This study also started with the planning stage on enhancing the use of tablets in teaching Grade R mathematics among pre-service teachers. A SWOT analysis, operationalising, observation and reflection stage followed it. All team members were involved and committed to solving the challenges throughout the process.

#### *3.2.4.1 Identifying the research issue or problem*

The process begins with identifying a specific issue or problem that affects the community or co-researchers. This issue should be significant, relevant, and directly related to the community's needs and interests.

#### *3.2.4.2 Forming the research team*

A research team, which includes the researcher and co-researchers, is formed. Co-researchers may comprise community members, stakeholders, and those directly affected by the issue. Collaboration and inclusion are key principles when forming such a team.

#### *3.2.4.3 Defining research objectives and questions*

The research team collaborates to define clear research objectives and formulate research questions. These questions guide the research process and help focus the investigation.

#### *3.2.4.4 Data collection*

Data collection methods are chosen based on the research objectives. Common data collection methods include interviews, focus groups, observations, and document analysis.

The research team actively collects data, with co-researchers often involved in data collection to ensure their perspectives are included.

#### *3.2.4.5 Data analysis*

Data analysis involves reviewing and interpreting the collected information. It can be done collaboratively with the research team, allowing multiple perspectives to inform the analysis.

#### *3.2.4.6 Reflecting and sharing findings*

The research team reflects on the data and its implications. Findings are shared with the community and other stakeholders through presentations, workshops, or reports. This stage often includes discussions about the significance of the findings and potential actions that can be taken.

#### *3.2.4.7 Action planning*

Based on the research findings, the team collaboratively develops an action plan. This plan outlines specific steps and strategies to address the identified issue or problem. Action planning involves setting clear objectives, timelines, responsibilities, and resources needed for implementation.

#### *3.2.4.8 Taking action*

The research team and the broader community or stakeholders implement the action plan, which can involve advocacy, policy changes, community projects, or other relevant actions. Co-researchers are actively engaged in the implementation process.

#### *3.2.4.9 Monitoring and evaluation*

Throughout the action phase, the team monitors progress and evaluates the impact of the actions. This assessment helps determine whether the actions are achieving the desired outcomes. Adjustments to the action plan may be made based on ongoing evaluation.

#### *3.2.4.10 Reflection and iteration*

The PAR process is cyclical, so the research team returns to a reflection phase after taking action and evaluating its impact. They consider what worked, what didn't, and what can be improved. This reflection often leads to identifying new issues or aspects to explore, starting the cycle again.

#### *3.2.4.11 Documentation and sharing of lessons.*

Lessons learned from the PAR process are documented and shared with the broader community, stakeholders, and other researchers. Sharing experiences and insights contributes to collective learning.

#### *3.2.4.12 Sustainability and long-term change*

PAR aims for sustainable, long-term change. The research team, community, and stakeholders continue to work together to ensure that the positive outcomes are maintained and expanded.

### 3.2.5 The epistemological stance of Participatory Action Research (PAR)

The epistemological stance of PAR is based on constructivism, emphasizing the co-creation of knowledge through collaboration between researchers and co-researchers, a focus on action and social change, reflexivity, and it appreciates the contextual and subjective nature of knowledge. It also seeks to empower individuals and communities by valuing their unique perspectives and experiences. According to the epistemology of PAR, the basis of knowledge is rooted in the lives and experiences of communities. The researcher generally forms it, and their co-researchers (Jacobs, 2016:49). PAR differs from traditional research as it focuses on research aimed at facilitating action.

PAR promotes a continuous cycle of reflection and action and actively involves co-researchers in the research process. PAR is an approach and method deeply committed to liberation, social change, and empowerment. PAR aims to improve lives, address oppression, and enable individuals and communities to achieve their full human potential. It is a powerful tool for social transformation and justice. This study upholds PAR's core principles and objectives and is aligned with its transformative and emancipatory goals.

### 3.2.6 Ontological stance of Participatory Action Research (PAR)

The ontological stance of PAR aligns with constructivist perspectives, emphasizing the social construction of reality, the subjective and contextual nature of reality, the importance of multiple perspectives, the dynamic nature of reality, and the acknowledgement of socially constructed power dynamics. This ontology underpins PAR's commitment to empowering co-researchers, addressing social injustices, and co-creating knowledge within the specific contexts of the research.

The concept of "praxis" plays a central role in emancipatory action research, aligning with this research approach's transformative and participatory nature. Praxis in the

context of action research refers to integrating action and reflection. It emphasizes that meaningful learning and change occur when individuals and communities engage in practical actions, reflect on their experiences, and use that reflection to inform future actions (James & Shaw, 2022:4). This cyclical process of action and reflection is fundamental to the transformative goals of emancipatory action research.

### 3.2.7 Rhetoric language

The language used in this study is aligned with the principles of PAR, which focuses on empowering individuals, stakeholders, and community members. It fosters collaboration, dialogue, and ethical research practices to drive positive social change. This study does not see co-researchers as objects but instead allows them an opportunity for growth through participation. Furthermore, the terminology used in PAR empowers the oppressed and marginalized (Johnson & Flynn, 2021:7). PAR focuses on promoting collaboration and open dialogue among researchers, co-researchers, and all other stakeholders involved. The language reflects a willingness to listen, learn, and engage in meaningful conversations. The opinions of the co-researchers were taken into consideration when developing the study. Co-researchers chose to use English, Sesotho and Isizulu as communication mediums as these were the languages the stakeholders were comfortable with; this facilitated proper communication and enabled power-building and maximize participation (Halliday et al., 2019:177). The languages used encouraged reflection and mutual learning in the research process and outcomes.

## 3.3 APPLICATION OF PAR IN THE CURRENT STUDY

This section describes the steps that PAR followed to design the strategy. During implementation, the steps followed by PAR are cycled through in a succession of cycles; the steps are 1) deciding on a course of action to change a particular procedure or circumstance, 2) taking action to carry out the plan, 3) monitoring the results of a decision in the context and under the actual circumstances in which it was made; and 4) using these results as a starting point for future planning, subsequent action, and so on through a series of cycles (Dlamini, 2018:89). PAR is suitable for this study because it allows free participation and commitment to the study.

## 3.4 THE RESEARCH SITE

The research site for this study was a TVET college in the Gauteng province. It is a public college, formerly known as a FET college, operating under the auspices of the Department of Higher Education and Training (DHET) in terms of the Continuing Education and Training Act, Act No 16 of 2006, as amended. The College is accredited by Umalusi and several Sector Education and Training Authorities (SETA's) to offer education and training, mainly in the FET band (NQF Level 2 to 4). The college provides both NCV and Report 191. With over 30,000 enrolments, the college is one of the biggest in the country.

The other site where the study was conducted is the primary school near the college where most ECD students go for their teaching practice. Though the school is also situated in the Gauteng Province, it is in the rural side of the province, where most of the students in the college come from. The school has 1084 learners from Grades R – 7. The location of the College and the school was conducive to using PAR because all those who were involved were easily accessible and fully participated in the study.

## 3.5 GAINING ENTRY

The team requested permission to conduct the study by writing letters to the principal of the college, the campus manager, the Senior Education Specialist, the education specialist of the ECD programme and Mathematics, the principal of the school, the Department of Education, and the Circuit Office. The researcher wrote letters to the identified team members requesting they participate in the study. Letters of consent were written and sent to the parents of the learners involved in the study to ask them to allow their children to participate. The problem under investigation was explained in the letter; their rights were also highlighted. The team selected a study coordinator who coordinated all the study activities and a scriber who took minutes in the meetings and invited members for meetings throughout the study.

## 3.6 CREDENTIALS AND ROLES OF THE RESEARCH TEAM

This section discusses co-researchers' credentials and the roles they played in the study as coordinating team members. It represents a broader group of people affected by the identified need. The research team has been recognised and established through negotiations with the Campus Management Team (CMT), the Education Specialists (ES), the HoD and the mathematics team has assisted in identifying the team different stakeholders involved in the study. The research team consists of the campus manager, HoD for NCV, mathematics ES, Education and Development ES, the foundation phase HoD, the Grade R class teachers, the ECD pre-service teachers who presented lessons under the supervision of their mentors and the IT technician who assisted with the projection of lessons. The college and school librarians helped learners and students connect to the internet. The focus was on pre-service teachers based on effectively delivering a fruitful mathematics lesson using tablets in teaching Grade R learners. Pre-service teachers developed lesson plans guided by the sequence of topics in the Grade R curriculum. The pre-service teachers were observed while teaching, and videos and photos were taken. Observation notes were transcribed, followed by the meetings to discuss the teaching strategies and skills observed. The research team monitored the proceedings of the whole process of data generation.

### 3.6.1 The study coordinator

The role of the researcher in PAR is dynamic and adaptive. It involves active engagement with the community and co-researchers, a commitment to social justice, and a focus on empowering marginalized voices. Researchers in PAR aim to create collaborative, democratic, and transformative research processes that lead to meaningful social change. However, my role as study coordinator is explicitly described, focusing on my role in this study. Besides initiating the study, I became a team leader and coordinated a co-researcher team. My role was also elucidated regarding the CER theoretical framework as coaching the study and relating it to PAR. After receiving the ethical clearance, I convened the first preparatory meeting with prospective co-researchers invited to participate in the study. I organised and conducted research with the research team, coordinated the research team's

activities, participated in collaborative planning meetings, and recorded generated data during collaborative planning sessions and lesson observations, which were further analysed and interpreted together with the research team. Furthermore, I ensured the ethical clearance processes were adhered to.

## 3.7 DATA GENERATION METHOD

With the co-researcher's permission, notes were taken during discussions and meetings, and all proceedings were recorded using recording devices. Data were generated through multiple meetings. Meetings were conducted with co-researchers at different times. For instance, I met with pre-service teachers, lectures, and teachers to explain the study's purpose. Minutes were taken at all meetings, and the attendance register was available for all members to sign. A strategic plan was formulated to identify priorities, responsibilities, and related actions, with time frames and resources for each activity to guide and monitor the data generation process and the SWOT analysis highlighting the possibilities, weaknesses, strengths, and threats to generate data. Our SWOT analysis meeting was also recorded. Videos were taken during practical sessions of lesson presentation, and all the above were done in adherence to the ethical guidance by always obtaining consent from co-researchers.

## 3.8 FIRST MEETING

The co-researchers gathered on a selected day that was suitable for them. The primary goals/aim of the first meeting were to introduce the study to the co-researchers and negotiate and plan using the PAR techniques of data collecting that would be used for the study. As a result, I began by holding a workshop to educate and prepare my research partners for PAR procedures and, more importantly, for the data collection techniques that might be used in PAR research projects. To help the stakeholders choose the best data-generating methods, I also listed the benefits and drawbacks of each data-generation technique. The lecture, the debate, and the conclusions regarding the best ways to employ were all audio-recorded and noted in the form of field notes.

## 3.9 COMMON VISION AND MISSION

An inspiring vision is a powerful tool for transforming practice. Disadvantages of each data generation method to help the stakeholders choose the appropriate data generation methods. Visions unleash four primary forces in an organization: attracting commitment and energizing people, creating a sense of purpose for people's work, establishing a standard of excellence, and bridging the present with the future. The lecture, the debate, and the conclusions regarding the best ways to employ were all audio-recorded and noted in the form of field notes (Martin et al., 2014:11). Enhancing the use of tablets to teach Grade R mathematics is a goal-oriented strategy that fosters a shared sense of purpose for the team. A task is an outcome of the core purpose; therefore, our vision is intended to convey where we are heading. Thus, the coordinated team and co-researchers work toward achieving clarity on a problem's complexity and nature by unifying efforts.

## 3.10 SWOT analysis and action plan

A SWOT analysis considers the notes' strengths, weaknesses, opportunities, and threats to generate data. Finding long-lasting answers and identifying threats that may obstruct the successful implementation and effective teaching of mathematics using tablets are attainable using a SWOT analysis. Initial planning meetings and our SWOT analysis meeting were also recorded. Researchers and co-researchers who attended brainstormed about different strategic actions and issues or problems to address. A team norm and an action plan were developed.

A SWOT analysis was further used to document the trends that transpired more formally in the drafting session and for pre-service teachers to specifically look at each of the four aspects from a critical stance. What is the state of readiness strengths within their classes? What are the weaknesses? What are the opportunities? And what are the threats that prevent the pre-service teachers from developing classroom readiness? This gave us a more detailed understanding of the baseline and what we had to work with. In the classroom, the following strategies for overcoming the difficulties of creating an effective teaching strategy for risk assessment were discussed and shared:

- Establish the co-researchers.
- Vision
- SWOT analysis
- Priorities –the five most important ones
- Executing the action plan

## 3.11 PRIORITISATION

Prioritization entails performing various tasks in a Grade R mathematics classroom, from identifying the actual problem to setting work priorities. In this situation, the goal is to design a strategy for pre-service teachers to enhance the use of tablets when teaching mathematics. The first step was to investigate the challenges faced when teaching Grade R mathematics during teaching practice, investigate potential solutions to these difficulties, identify favourable circumstances for their implementation, foresee potential threats to the emerging strategy and take steps to mitigate them and determine possible means or suggestions that can be proposed as effective strategies.

## 3.12 STRATEGIC PLANNING

People and organizations use a strategic plan to determine what is effective and what is not (George, 2021:793). Strategic planning enables co-researchers to grow and engage in group learning to bring about positive change (Ferrer-Estévez & Chalmeta, 2021:12). It further brings people together in organizations to plan their future; it helps people to investigate and reflect on their own needs, wants, and desires. This optimistic method is predicated on the premise that every human system has a positive core of qualities built on fresh, imaginative concepts, visions, and narratives that elicit feeling and motivate action (Quaintance, 2021:7).

***Table 3.1: Activity plan***

| Activity | Responsibility | Monitoring | Evaluation | Time |
|---|---|---|---|---|
| **1st Priority: Preparatory phase**<br>Initial planning meetings | Co-researchers | Co-researchers | - Attendance of all stakeholders, brainstorming and developing team norms and action plans. | One-hour meeting for 4 weeks |
| **1st Priority: Phase 1**<br>Strengthening the disciplinary learning using tablets. | Researcher, Co-researchers | Co-researchers | - Discussion of challenges and success stories experienced by pre-service teachers when teaching mathematics with tablets.<br>- Discussion on how to overcome such challenges. | Two months |
| **Priority 2:**<br>**Phase 2**<br>Arrange a training session on how to embrace pedagogical learning | Co-researchers<br>Researcher | Attendance of co-researchers in the training session. | - Discussion on benefits of using tablets when teaching mathematics.<br>- Discussion on interactive teaching and learning. | 2 hours<br>Twice a week for 3 months |

| | | | | |
|---|---|---|---|---|
| **Priority 3:**<br>**Phase 3**<br>The observation of the lesson presentation during practical learning | Co-researchers including learners | - Facilitating the process of teaching and learning mathematics using tablets<br>- Using Apps to learn through play. | - Discussion on more effective ways to encourage interactive learning. | 1 hour<br>Three times a week for 3 months |
| **Priority 4:**<br>**Phase 4**<br>Supporting pre-service teachers to effectively use modernised teaching methods in the classroom. | Co-researchers | - Engage in the effectiveness of using tablets when teaching mathematics. | - Presentation by in-service and pre-service teachers to further prepare on how pre-service teachers can engage learners during their lesson when using tablets. | 1 hour<br>Three times a week for 3 months |
| **Priority 5:**<br>**Phase 5**<br>Reflection of the lesson | Co-researchers including learners | - After every observation of each lesson, the lesson was discussed. | - The co-researchers mentioned what went well and recommended how to improve in the future. | 1 hour<br>Three times a week for 3 months |

Each activity plan consisted of five phases, as shown in Table 3.1 above. These phases were systematically constructed to imply several dimensions. However, the phases were carried out sequentially per the recommendations of the PAR approach, which was then followed by reflection on the change that led to re-planning and the development of plans. Co-researchers from the community brought a richness of expertise essentially valued to steer this study as new knowledge was co-constructed through negotiated meaning. The community's co-researchers contributed a wealth of experience primarily recognized in guiding this study as further information was jointly generated through negotiated meaning. One should adopt the play teaching approach to enhance the use of tablets in teaching Grade R mathematics.

### 3.12.1 Priority One (Phase One)

In phase one, teaching mathematics using tablets was introduced. Discussions of challenges and solutions experienced by pre-service teachers when teaching mathematics with tablets and creating interactive lessons assisted pre-service teachers in finding strategies to enhance the use of tablets when teaching mathematics. Discussions were shared on how disciplinary learning can be strengthened in teaching mathematics using tablets and different strategies.

### 3.12.2 Priority Two (Phase Two)

During the second meeting with the pre-service teachers, in-service teachers and lectures, discussions about solutions to the challenges pre-service teachers face when teaching mathematics with tablets continued. One of the challenges identified during the meeting was the lack of disciplinary learning in mathematics, which affected pre-service teachers' confidence when delivering lessons. Co-researchers suggested using subject committees to strengthen the mathematical content of the pre-service teachers.

### 3.12.3 Priority Three (Phase Three)

All prepared and presented lessons were observed during this phase to motivate pre-service teachers to deliver engaging lessons and encourage play-based learning in

their classrooms. All lessons presented were observed and conducted in a 4-6-year class. Each pre-service teacher presented a lesson using tablets to teach mathematics. All the present co-researchers observed and took notes discussed during the subject committee meeting where the pre-service teachers are being empowered instead of criticised.

### 3.12.4 Priority Four (Phase Four)

During this phase, pre-service teachers and learners were assisted in the areas where they seemed lacking. Additional support was given to the pre-service teachers, and a programme of action was drawn to support the identified gaps. Meeting with the Education Specialist, pre-service teachers from the nearby university and other professionals who could assist in closing the gaps were identified, like lecturers teaching mathematics in the foundation phase at a nearby university.

### 3.12.5 Priority Five (Phase Five)

All the co-researchers who were part of the observation of the lesson presentation came together to reflect on all the lessons presented and observed. Pre-service teachers had the opportunity to consider what they had learned throughout their lesson presentations and how their lesson presentations differed from previous ones. As noted on the consent form, all the meetings were held in English, isiZulu, and Sesotho to ensure that everybody understood. This was done so that the co-researchers could have enough time to hear all the members' opinions before starting to analyse the data; all co-researchers were allowed to share their thoughts throughout the meetings. The co-researchers' responses were recorded using a recording tool. Data were gathered and analysed from the observations of the lesson presentations and meeting discussions. The lesson presentations were based on the five research objectives and requested a discussion of the difficulties of using tablets effectively when teaching mathematics. CDA was used to analyse the generated data (Schiffrin et al., 2001:1).

## 3.13 DATA ANALYSIS

CDA was utilized to analyse the generated data, focusing on the ways discourse structures enact, affirm, reproduce, or question social power and dominance relationships (Schiffrin et al., 2001:1). Text and discussion also made references to discourse about power and dominance (Schiffrin et al., 2001:18). One analytical study method known as CDA analyses speech critically in terms of how social power is misused. Inequity is implemented (Van Dijk, 2001:352). One of the goals of enhancing the use of tablets in teaching Grade R mathematics is to create power relations to do better in the future and to be critical thinkers, problem solvers, creative, and self-confident. We are empowering children to feel valued in a team and have the power of their knowledge (Habibie, 2016:13). Van den Week used the exclusion and inclusion approach to analyse how the actor in discourse has been presented, whether the actor has been shown in whole, or partially, or even completely deleted, in his book *Speech and Practice* (Van Leeuwen, 2008:28–29). Costs of exclusion or those of removal are discourse actors. The analysis of the study's data, including photos, videos, audio recordings, learner activities, core searchers' reflections, and lesson presentations, was done using the CDA model. The text (description) and discourse practice (interpretation), which were used to analyse it, according to Magunje and Chigona (2021:89), are used to create identities and social connections. This section explains the relationship between the social-cultural practice and the "connection between the discursive processes and the text.": At this level, analysis of the social settings in which the content is produced, disseminated, consumed, and understood is necessary (Magunje & Chigona, 2021:89).

### 3.13.1 The characteristics of Critical Discourse Analysis (CDA)

Critical Discourse Analysis (CDA) refers to an attempt or parsing procedure to clarify or explain a text (social reality) carried out by a person or group of dominant tendencies with a predetermined goal. CDA is used to analyse texts, conversations, media, and other forms of communication to uncover hidden power relations, ideologies, and social structures (Nasution et al., 2022:4993). This analytical framework has been applied to various domains, including politics, media, education, and corporate communication, to reveal how language can be a tool for social control, resistance, or

transformation. Notably, CDA deals with discursive power relations (Nasution et al., 2022:4993).

### 3.13.2 Feminist Critical Discourse Analysis (FCDA)

Feminist Critical Discourse Analysis (FCDA) is a specific strand of CDA that examines language use from a feminist perspective. Like CDA, FCDA seeks to explore how language contributes to constructing and perpetuating power relations, social inequalities, and gender norms. However, FCDA specifically addresses gender-related issues, seeking to uncover how language is involved in the reproduction and challenge of gender-based hierarchies and stereotypes (Nasution et al., 2022:4994).

To analyse how language and gender relate, FCDA primarily looks at how men and women exercise power in public. Research shows that social and cultural factors most likely cause perceived or actual variations in cognitive performance between males and females. For instance, experts think social context significantly influences test results where there have been differences between females and boys (García-Peñalvo et al., 2016:13). In this study, the notion that boys can perform better than girls should not be considered (Tenorio, 2011:97). To experience technology in a new way, combining new settings and new learning environments, and allowing the kids to use their imaginations, both girls and boys need access to the right tools. Finally, kids require early identification with role models like women in STEM (García-Peñalvo et al., 2016:14).

### 3.13.3 Critical Discourse Analysis (CDA) approach

This study is not focused on the origins of CDA but on how it was applied to text and speaking to analyse, interpret, and explain endorsed inequalities and domination. Van Dijk's socio-cognitive methodology applies to this investigation. An approach characterized by the connection between discourse, cognition, and society is Van Dijk's socio-cognitive discourse analysis (Shah & Yasir, 2021:665). The perpetuation of racial prejudice, stereotypes, minority groups abusing their power, and dominated group`s resistance are all significant topics of Van Dijk's empirical research. Van Dijk highlighted the use of discourse control to access power (Jahedi, Abdullah & Mukundan, 2014:32). This study concludes that among these approaches the interplay

between cognition, discourse, and society is what makes Van Dijk's Socio-Cognitive Discourse Analysis an effective method (Jahedi et al., 2014:33). CDA was employed to analyse, interpret, and justify enacted disparities and supremacy through text and speech (Mceleli, 2019:195). This study aimed to identify discursive practices, social structures, and hidden power connections in text using CDA that could potentially constrain pre-service teachers in enhancing the use of tablets when teaching Mathematics (Jahedi et al., 2014:32).

The pre-service teachers were in charge in the classroom rather than opting for a child-centred approach; the social circumstances of interaction between cognition, discourse, and society can recognize the issue of power and its misuse and enable the co-construction of knowledge with the learners.

## 3.14 ETHICAL CONSIDERATIONS

Ethical consideration is an integral part of research. Since this study involves pre-service teachers, the children, lectures and the parents, the researcher subjected the research to ethical considerations. This research complied with the Department of Higher Education and Training (DHET), the Gauteng Department of Education's ethical policy, and the University's. Consent and assent were requested from all co-researchers to ensure their respect, rights, feelings and justice. When planning and carrying out this research, the researcher considered gender roles, ethnicity, ability, age, sexual orientation, language, and other differences. The researcher also ensured that the research was conducted with honesty and integrity about human rights, cultural differences, children's rights, customs, and religious beliefs and practices of all participants. The Protection of Personal Information Act (or POPI Act), which protects one's personal information, came into effect in July 2021 (RSA, 2021). Since we worked with children, the Children's Rights Act (Children's Amendment Bill B18-2020 – RSA, 2021) was adhered to. We got permission from the parents, blurred the children's faces, covered them with emojis and only uploaded photos from behind. The name of the TVET College and the school where the research was conducted were not explicitly mentioned. The research was conducted inside the classroom where learning takes place.

## 3.15 VALUE OF THE STUDY

This study is significant because it will provide strategies to enhance the use of tablets when teaching Grade R mathematics among pre-service teachers in the classroom. This study was helpful to the pre-service teachers, lecturers, education specialists, learners, parents, and in-service teachers. This study benefited the Senior Education Specialists, policymakers and programme developers in developing quality material, online tools, and training of pre-service teachers and thinking of digitising all the teaching material and tools. The study may be helpful for teaching and preparing kids to solve problems, think critically, collaborate creatively and creatively, function in a digital and information-driven world, apply digital and ICT skills, and transfer these skills to solve everyday problems and their possibilities, including preparing learners for meaningful and successful living in a society that is changing and transforming quickly (DBE, 2018:12).

## 3.16 CONCLUSION

The methodology and research design employed to conduct this study were the main topics of this chapter. PAR methodology was used to address the critical research topics. The PAR approach was suited for this study because it aimed to design a strategy to enhance the use of tablets in teaching Grade R mathematics. Purposive co-researchers' identification and selection methods were utilized for the study's participants. Strong ethical concerns were implemented because the study involved learners not of legal age. All "gatekeeping" authorization was requested and subsequently secured, and participation was voluntary. All people involved provided written consent, and those who were minors received parental or guardian consent. Throughout the whole study, anonymity and confidentiality were upheld. The following chapter focuses on data analysis and a discussion of the findings, plan, and implementation.

# CHAPTER 4
# ANALYSIS OF DATA, PRESENTATION, AND INTERPRETATION OF RESULTS

## 4.1 INTRODUCTION

This study aims to design a strategy for effectively using tablets in teaching Grade R mathematics among pre-service teachers at a TVET college in Gauteng. Data are categorised according to the five objectives of the study, namely, identifying the challenges experienced by pre-service teachers when teaching Grade R mathematics using tablets, finding solutions to those difficulties experienced, analysing the conducive factors, identifying the possible threats and detecting whether the solutions of the challenges identified are effective. Each objective is unpacked in terms of identified relevant constructs that constitute it, which emerged from the literature review, and appropriate sub-headings are formulated.

To better understand the objectives, they are subdivided according to subheadings corresponding to the constructs identified in Chapter 2. These are organised with the introduction of each objective discussing policy, theory, findings from previous research and legislative imperatives. Extracts retrieved from empirical data are then analysed in the context of the opening paragraphs, trying to prove their relevance to the study. To further confirm the reliability of the evidence provided, the evidence against the findings is reflected by the co-researchers' conversations and verifiable data from the text.

The data has been analysed and interpreted using CDA. According to Sharkawy (2019:6), CDA is used to analyse how language at the contextual and social structural level is being used to excavate the interpretations informed by how society is organised. Rogers (2004:59) and Van Dijk (1995:18) discussed how CDA is used to uncover the elements of dominance, power relations and inequality at the textual level. Furthermore, Mahlomaholo (2012:51) stated that CDA is used to obtain a deeper meaning of the text, which is more than just sentence structures. In addition, CDA exposes social inequalities (Van Dijk, 2008:85) that may have constrained the emancipation of teachers in terms of their TPACK. This process will be repeated for all the objectives using PAR.

## 4.2 IDENTIFICATION OF CHALLENGES TO THE IMPLEMENTATION OF THE STRATEGY

The following challenges are identified, namely (i) Limited Disciplinary Learning in Mathematics using tablets; (ii) Lack of Morden Pedagogical Learning in teaching mathematics (iii) Inadequate WIL (iv) Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics) and (v) Challenges in Situational learning (general classroom management when using tablets to teach mathematics).

### 4.2.1 Limited Disciplinary Learning in Mathematics using tablets.

According to MRTEQ Policy (2011), disciplinary learning, also known as the subject matter knowledge, in mathematics refers to the content, theories, concepts, principles, and skills that constitute the field of mathematics. Previous research has proven that teachers with deep subject matter knowledge can explain complex mathematical concepts clearly and concisely. Therefore, pre-service teachers' programs must be aligned and strengthened to ensure that the pre-service teachers are experts in mathematics. Limited disciplined learning in mathematics by using tablets can hinder pre-service teachers' effectiveness in teaching the subject and finding engaging ways to enhance learners' understanding of mathematical concepts (Siyepu & Vimbelo, 2021:3). Siyepu and Vimbelo (2021) further suggested that pre-service teachers should be able to extract the content and interpret the curriculum recommended for the phases they specialise in. McGraw-Hill (2019) stated that (TPACK) theoretical framework has been developed to clarify and explain the set of knowledge that needs to be taught by teachers and to teach mathematics effectively using technology. TPACK is crucial for pre-service teachers since they are the future educators expected to mould the new generation (Santos & Castro, 2021:2).

Mathematical content knowledge indicates the extent to which pre-service teachers understand the mathematics content and how well they can explain and model concepts, guide learners and expand their thinking. When pre-service teachers complete their preparation programs, they need comprehensive knowledge beyond the mathematics they will teach and an understanding of learners' conceptual development and misconceptions. Despite the wide acceptance of technology as an

effective teaching tool, many teacher preparation programs focus on technology skills rather than blending technology into pedagogy for a whole new approach. While pre-service teachers are often comfortable and adapt to using technology, they need more support to develop the knowledge and skills to integrate it into their teaching effectively. Technology applications frequently focus on mathematics procedural fluency rather than conceptual understanding, which becomes a challenge when pre-service teachers present lessons in class, and they opt for traditional methods which do not require them to use tablets or any other technological tools.


***Figure 4.1: Learners doing an activity on space and shapes.***

In Figure 4.1, the pre-service teacher has given learners an activity on space and shapes to draw and colour a circle and a square. The learners are only expected to use pencils, paper, and crayons. Learners cannot utilize tablet interactive apps that focus on specific mathematical concepts. Interactive apps are advantageous because they provide a hands-on experience for learners, making abstract concepts more tangible.

***Figure 4.2: Sipho's activity.***

In Figure 4.2, it is evident that Sipho did not understand the instructions as they were given verbally without any demonstration. Teaching mathematics without tablets delays feedback deprives learners of an opportunity to adapt learning and might delay progress tracking to tailor the learning experience to individual needs.

***Sipho*** *asked:*

> *"Teacher, can I draw another rectangle that has four sides?"*

**Zaza** (pre-service teacher) answered:

> *"Why would you draw a rectangle with sides, Sipho? Because I said draw a circle and a square?"*

Ms. Nkosi (an experienced teacher) intervened by asking learners to name and count the sides of each shape pasted on the wall before continuing the activity.

Schmidt et al. (2009) defined TPACK as the knowledge that teachers and pre-service teachers must integrate technology fully into the curriculum. To effectively deliver content using the three essential components of knowledge (CK, PK, and TK), teachers and pre-service teachers must have an intuitive awareness of the intricate interplay between them (Schmidt et al., 2009:135). Teachers must be knowledgeable in these three areas. Still, more importantly, Koehler and Mishra (2009) contend they must also be able to combine their technological, pedagogical, and content expertise (Schmidt et al., 2009:135).

Posthumanism is a theoretical perspective that challenges traditional notions of human identity and emphasizes the transformative impact of technology on human existence. Young children use apps on technological devices like tablets to engage in fun games effectively as they learn through play by drawing on them and playing interactive games. Posthumanism considers the embodied nature of learning. In mathematics education, this can involve using digital spaces and virtual environments where learners can manipulate mathematical objects, visualize abstract concepts, and engage in embodied learning experiences that transcend the physical classroom.

As explained in Chapter 3, CDA is an approach that examines language use to uncover power relationships, social structures, and ideologies. Applying CDA in the mathematics classroom can assist teachers and learners in critically engaging with mathematical discourse, exploring social implications, and fostering a deeper

understanding of the subject. CDA helps to reflect on the language and discourse surrounding digital inclusion in mathematics education. Examine how technology is presented as an inclusive tool, addressing, or possibly exacerbating issues of access, equity, and diversity in mathematical learning (Figure 4.2). There is no inclusivity of technology; learners are disempowered and unable to explore their mathematical skills using tablets, and all powers for feedback are vested in the teacher. Zaza expected the learners to do precisely as she said, they could not explore and broaden their scope.

As Zaza presented her lesson and gave learners an activity, she frequently asked if they understood what she was saying; this was apparently a way of coercing them to appear to be part of the presentation. This discursive practice is socially accepted as learners regard it as natural that when they are asked if they understand, they should automatically say yes. The positioning of the teacher under this interaction genre makes teachers very powerful in terms of being the only ones who determine what takes place in the classroom, which was evident when Sipho asked a question; he was told to follow the instructions given. The structural arrangement does not readily permit learners to ask questions but to respond to questions and follow instructions. Learners' voices are muted, and they must learn the rules without questioning or understanding.

Mathematics enhances critical thinking skills. It teaches individuals to analyse situations, identify patterns, and make logical deductions, valuable skills in various professional and personal contexts. The subject matter knowledge in mathematics is vital for academic success, developing essential life skills, and preparing individuals for a wide range of careers and challenges in the modern world. Teachers with solid subject matter expertise are pivotal in nurturing the next generation of mathematicians, scientists, engineers, and critical thinkers. Pre-service teachers must be taught to use teaching strategies and tools to enhance learners' understanding and engagement with the subject.

### 4.2.2 Lack of Morden Pedagogical Learning in teaching Mathematics using tablets

As stated in the MRTEQ policy (2011), pedagogical knowledge is a prerequisite that satisfies every program in training teachers. Pedagogical knowledge refers to the understanding of teaching methods, learning strategies, classroom management techniques, and the ability to adapt teaching to the diverse learning needs of learners. It promotes active learning, critical thinking, and problem-solving skills, preparing learners not only for academic success.

Previous research has proven that a lack of pedagogical learning in teaching mathematics with tablets hinders a dynamic, interactive, and learner-centred learning environment. It denies teachers the skills to leverage technology effectively, promoting more profound understanding, engagement, and overall positive learning outcomes in mathematics education (Naomi et al., 2016:124).

The technological pedagogical content knowledge (TPACK) model (Koehler & Mishra, 2009; Mishra & Koehler, 2006) argues that technological knowledge must be considered together with content and pedagogical knowledge rather than separately. This framework suggested that for digital technology to support the learning process effectively and pre-service teachers' classroom practices, pre-service teachers must understand how best technology can be used within their curriculum while using what is widely accepted to be the most effective pedagogy for this. As such, in mathematics, developing teachers' TPACK involves strengthening pre-service teachers' understanding of the mathematical content and their knowledge of the misconceptions that can occur, furthering their knowledge of how learners learn and get used to technology and how this can enhance the teaching and learning process (Attard et al., 2014:3).

Pedagogical learning is essential for teachers as it underpins effective teaching practices, supports learner engagement and motivation, fosters critical thinking skills, and contributes to creating an inclusive and equitable learning environment (Attard et al., 2014:6). Extensive pedagogical knowledge can enhance the overall quality of education, benefiting both teachers and learners. Pedagogical learning equips teachers with the necessary knowledge and skills to deliver effective learning.

Teachers learn how to present information, facilitate discussions, and engage learners meaningfully, leading to enhanced learning outcomes.

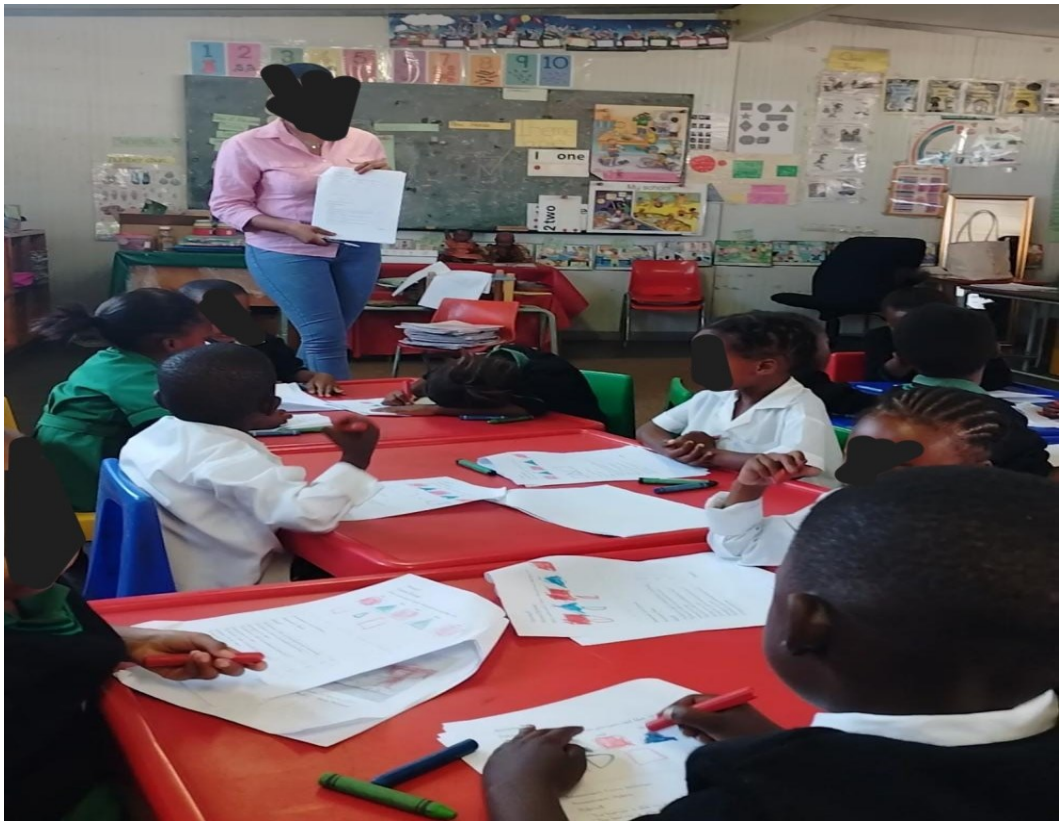



***Figure 4.3: Pre-service teacher offering a lesson.***

In Figure 4.3, the pre-service teacher is standing in front of the class giving instructions, which is mainly a traditional teaching method of teaching mathematics. The teacher-centred approach encourages the pre-service teachers to deliver content through direct instruction, explaining mathematical concepts, procedures, and problem-solving strategies to the entire class. It does not allow learners expanded opportunities, and it does not promote individualised learning.

As discussed in Chapter 2, pedagogical learning promotes active learning methods where learners are actively engaged in the learning process. However, Figure 4.3 shows that the pre-service teacher is still comfortable with the traditional teaching method. According to Valera (2014:481), posthumanism is a total contamination and hybridization of human beings with other living beings and technological machines. Posthumanism in teaching mathematics involves reconsidering traditional perspectives on education, human identity, and the relationship between humans and

technology. Posthumanism challenges the idea of a fixed and stable human essence, suggesting that our understanding of what it means to be human constantly evolves, especially in the era of advanced technologies.

Ms. Khumalo (an experienced mathematics teacher) applauded Nomusa (the pre-service teacher) for presenting her lesson well and keeping order during her presentation. However, Mr. Mbewe (a newly appointed didactics lecturer) commented,

*"Nomusa, you need to explore and make your lessons more engaging."*

From the observation and discussion with co-researchers, it was highlighted that it is essential for pre-service teachers to be taught pedagogical learning that is learner-centred, interactive and promotes the use of technology in the classroom because it enhances learners' participation, critical thinking, and problem-solving skills, leading to a deeper understanding of the subject matter.

Posthuman pedagogy challenges traditional teaching and the relationship between the learner and what learners learn. Therefore, intra-action is suggested to resolve such a challenge (Yan et al., 2020:2314). Posthumanism does not view learners as empty vessels who cannot contribute to new knowledge (Yan et al., 2020:2315).

In intra-action, the pre-existence of entities is not assumed (Posta, 2016), and learners are not defined by the pre-subscribed characters and abilities that the learner identity is usually associated with. The pedagogy practice that embraces posthumanism should understand that learners can also produce knowledge rather than just knowledge consumers (Yan et al., 2020:2314; Murris, 2017). However, the teacher-centredness that prevailed in this class did not allow learners an opportunity to express their views. From the empirical evidence thus far discussed, it appears that the pre-service teacher did not regard learners as active agents in their knowledge construction but treated them as empty vessels who did not have any ideas to share with others.

While discussing the lesson, the researcher and co-researchers also noted that Nomusa had presented her lesson as per the content that is being taught to pre-service teachers at college, and it only focuses on the presentation of the lesson; it does not say much about the involvement and participation of learners in the classroom. Hence, Nomusa did not see anything wrong with standing in front and not

actively involving learners. The current teaching strategies taught to pre-service teachers are teacher-centred and do not embrace any modern teaching strategies.

According to the DBE (2016:18), teachers must recognise that teaching is an active process. The SA Education Policy Framework also advocates for learner-centred approaches through curriculum aims that intend to produce learners who can investigate, reason logically, analyse, represent, interpret information, communicate, and solve problems (DBE, 2011:9). The DBE (2011:4) purports that al earner-centred method of teaching accommodates a deep approach to learning to allow learners the opportunity to develop and employ critical thinking skills. The uniqueness of learners and their different learning styles were overlooked. This view of teacher-centredness denied learners the opportunity for active involvement and self-directed learning where they could pose questions and choose the learning materials that best suited their learning styles.

As mentioned earlier, posthumanism challenges researchers to interrogate and dismantle the humanist structures which numerous education systems rest upon (Blaikie et al., 2020:3). The teacher-centred approach mostly appears to be a sign of a lack of pedagogical knowledge, does not promote learner engagement, critical thinking, creativity, and does not motivate learners. It often creates a passive learning environment where learners are less likely to participate and take ownership of their learning actively. Learners are perceived as empty vessels; they are not allowed to participate actively in the learning process.

The study's results indicated a lack of Morden pedagogical knowledge, which resulted in a teacher-centred approach. Teacher-centred approaches lack the flexibility to adapt to the diverse needs of learners. Learners with different learning paces, interests, and backgrounds may struggle to thrive in such an environment. Limited interaction between learners can hinder the development of communication skills. Collaborative learning and peer-to-peer interactions, essential for social development, are often underemphasized in teacher-centred classrooms. As an unintended consequence, caused by the non-availability of learners' opportunities to pose questions in a mathematics class that does not embrace a learner-centred approach, learners are subjected to learn rules without reason, which is a practice that is in contrast with critical thinking and reasoning enshrined in CAPS mandates (DBE, 2011:4).

### 4.2.3 Inadequate Work-Integrated Learning (WIL)

Practical learning, also known as Work-Integrated Learning (WIL), is an essential condition for the development of tacit knowledge, which is an integral component of learning to teach (MRTEQ 2011:8). According to the study conducted by Ngubane et al. (2020) not all levels of the NCV programme gets priority for the WIL and that is against the principles underpinning the NCV curriculum which clearly states that students must gain experience from local industries and local institutions to complete their programme (Ngubane et al., 2020:7). WIL experiences for pre-service teachers in mathematics provide a bridge between theory and practice. These experiences are essential in shaping effective and culturally responsive teachers, ensuring they are well-prepared to meet the diverse needs of learners in natural classroom settings.

WIL aims to give pre-service teachers expanded opportunities to enhance their skills using modern teaching strategies, including technological tools like tablets, when teaching mathematics. Giving pre-service teachers adequate time for teaching practice will allow them to identify and address potential challenges and barriers that may arise when using tablets in the mathematics classroom (Ngubane et al., 2020:7). Furthermore, providing pre-service teachers with substantial teaching practice using tablets ensures that they are well-prepared to use technology effectively and creatively in their future classrooms (Moreno, 2022:724). This preparation benefits the teachers and enhances their prospective learners' learning outcomes and experiences.

In the challenge highlighted in 4.2.2, during the discussion, the pre-service teacher noted the analysis of the lesson, and she also reflected on the presentation. However, because of limited time during teaching practice, she could not return and present her areas of improvement as she was supposed to return to college. She might be granted another opportunity after four months, which does not guarantee that she will still remember and be able to implement the recommendations made by then.

> **Queen:** *“I am currently in level 3 and only went for observation once in level 2. I can’t even remember what was happening; hopefully, this year, I will be placed.”*

The Education Specialist highlighted that they now have many students, which makes it difficult for the placement officer to place all of them; unlike in other learning institutions like universities and private colleges, TVET colleges have a structured way

of placing students, which must always be followed, and schools also do not allow many students to come for teaching practice at the same time.

> **Mr Mbewe:** *"And the unfortunate part is that, unlike other programmes, the ECD programme cannot place its students during school holidays as most schools are usually closed. Only daycare centres are open, and they cannot accommodate all students."*

The increasing number of students in the TVET sector makes workplace exposure more difficult. The ETDP SETA (2022) report also highlighted concerns about the readiness of TVET colleges when students must be placed; one of the measure challenges was the limited time pre-service teachers spend at the workplace.

During practical learning, pre-service teachers can explore technology in the classroom, integrating digital tools and resources to enhance mathematics content. WIL experiences allow them to implement technology-based activities and assess their impact on learners' understanding. WIL experiences help pre-service teachers transition from the role of student to that of a professional teacher. They gain confidence, practical skills, and a deeper understanding of the complexities of teaching, preparing them for their future careers in education. Pre-service teachers can gain experience in designing assessments, evaluating learner performance, and providing constructive feedback. WIL experiences allow them to implement various assessment methods, such as formative assessments, quizzes, and projects, and analyse their effectiveness.

The NCV program consists of the theory component as well as the practical component. The theoretical knowledge is assessed through Internal Continuous Assessment (ICASS), and an Internal Summative Assessment Task (ISAT) is employed to assess the practical component. The student is also expected to acquire the WIL, usually done at primary schools and daycare centres. During ISAT presentations, it was evident that pre-service teachers who went for teaching practice did well compared to those who did not go or had limited time. Those who went used modern teaching strategies when presenting and incorporated tablets in their presentations. All their presentations were interactive.

### 4.2.4 Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics)

Research has shown that pre-service teachers lack pedagogical training, which results in low ICT competency skills confidence and eventually leads to internal barriers such as negative attitudes towards the use of digital technologies (Dewa & Ndlovu, 2022:2). Even though TVET colleges may have suitable educational software. Still, suppose pre-service teachers have limited access to ICT because of rigid structures of traditional education systems and restrictive curricula barriers. In that case, it becomes difficult for them to use ICTs during their teaching practice (Dewa & Ndlovu, 2022:2).

> **Teezo:** *"It is very difficult to prepare lessons using technology because, in class, we present without using all those."*
>
> **Ms. Mahlangu:** *"During lessons at the college, our focus is on the content of mathematics simply because that is what we assess at the end of the year. We should consider doing things differently in future."*

Ms. Mahlangu's utterances show that most mathematics lectures do not integrate ICT during their lessons; they prefer to teach without technological tools because they seem to be doing well (Makonye, 2017:205). Although South Africa may have ICT policies in education, these policies do not specify how mathematics teaching should be taught using digital technologies. There is a gap in policy for initial teacher education institutions (ITEIs) and their lecturers, who are expected to prepare pre-service teachers to use ICTs for teaching (Act No. 67 of 2008).

Suppose mathematics lecturers at a college can use ICT during their lessons. In that case, pre-service teachers can develop the desired cognitive and pedagogic skills they need for their prospective teaching environments (Dewa et al., 2022:3). The mathematics curriculum is disconnected from its contextual use (i.e., classroom teaching). It creates a gap in the knowledge package that pre-service teachers must be relevant to the contemporary classroom (Makonye, 2017:206).

### 4.2.5 Challenges in Situational learning (general classroom management when using tablets to teach mathematics)

Situational learning refers to different types of learning situations, contexts, and environments of education, such as classrooms and communities, as well as to prevail

policy, political and organizational contexts (MRTEQ, 2011:9) (cf. 2.4.1.5). Situational learning also refers to a learning approach that emphasizes the context or situation in which learning occurs. It focuses on real-life experiences and encourages learners to apply their knowledge and skills in specific, authentic situations. Situational learning often involves problem-solving, critical thinking, and the practical application of concepts to address challenges or tasks relevant to a particular context.

**Nomsa:** *"Making sure that all tablets are switched on is tiring and time-consuming."*

From the statement above, it is evident that pre-service teachers view teaching with technology as problematic rather than as an interactive way of learning. During the observation sessions, it also became apparent that pre-service teachers had challenges with learners' behaviour in class, and ensuring responsible tablet use can be challenging, mainly if learners are not accustomed to using technology in the classroom. Pre-service teachers struggle to balance digital and traditional instructional methods, leading to concerns about excessive screen time. Integration of tablets into the existing curriculum is also seen as a challenge for pre-service teachers.

## 4.3 SOLUTIONS

This section provides possible solutions from the literature as conceptual guidance on factual evidence and empirical data of the practical teaching strategies of enhancing the use of tablets in teaching mathematics using tablets, as discussed in 4.2. The following evidence of solutions to the challenges is identified, namely (i) The establishment of subject committees to strengthen the content knowledge of pre-service teachers; (ii) Self-efficacy for technology integration; (iii) Creating a strong partnership between TVET colleges and Industry; (iv) Modifying the pre-service teachers programme at TVET colleges; and (v) Aligning the NCV curriculum with the industry needs.

### 4.3.1 The establishment of subject committees to strengthen the content knowledge of pre-service teachers

The impact of subject committees in emancipating pre-service teachers in terms of their TPACK has been explored. Sharing good practices allows one to learn from each

other (Mosia, 2016:137) by exploring diverse strategies. According to Mosia (2016:137), teachers find a safe space when they are with their peers to communicate, share and address issues, observe one another's work, and develop expertise in various aspects. Teamwork resonates with the ontological stance that embraces a shared reality that allows the nature of reality to be critically examined by intersubjective views (Mertens, 2021:81). Teams strengthen competencies and promote collegiality. On the other hand, it reduces professional isolation and helps individuals to overcome weaknesses.

The TVET curriculum instruction and CAPS document encourage teamwork and respect for others. Teamwork promotes an active and critical approach to learning. In addition, a team creates a platform for individual mathematics pre-service teachers, teachers, and lecturers to share their frustrations and success stories regarding teaching mathematics in a safe environment without being afraid to be judged. The interaction of team members bringing multiple realities and their subjective worldviews about their lived experiences in the mathematics classroom allows them to choose what seems to work for different classroom contexts, enabling the pre-service teachers to broaden their mathematical knowledge.

As we were planning and reflecting, the team came up with different ideas on how best to assist the pre-service teachers in improving and developing their content knowledge in mathematics. As a team, we were guided by PAR perspectives that a researcher should be available to assist the co-researchers and not only act as an outsider to extract knowledge but also actively participate in the research process without self-imposing.

### 4.3.2 Self-efficacy for technology integration

Self-efficacy for technology integration by pre-service teachers in mathematics refers to the belief and confidence that these aspiring teachers have in their ability to effectively use technology tools and resources to enhance the teaching and learning of mathematics. It reflects their perception of their own capabilities in utilizing technology to support students' mathematical understanding, engagement, and achievement.

Lestari and Indrasari (2019) defined self-efficacy for technology integration as an essential factor that influences teachers' actual use, acceptance, or adoption of technology in teaching. It also refers to teachers' confidence in their capabilities to incorporate technology into teaching to facilitate student learning successfully (Hur et al., 2015:17). Teachers with higher levels of technology integration self-efficacy are more open to new ideas, strategies or experiments for incorporating technology to create learning opportunities and are more willing to put forth continuous efforts to tasks that involve the use of technology (Anderson & Maninger, 2007).

Pre-service teachers' self-efficacy regarding mobile technology integration is highly related to their intention to adopt mobile devices in teaching (Menon et al., 2017; Burden & Hopkins, 2016; Hur et al., 2015). Hur et al. (2015) explored factors affecting pre-service teachers' intention to use mobile devices for teaching through structural equation modelling (SEM). Self-efficacy for technology integration significantly influences the intention to use mobile devices in both direct and indirect ways. Burden and Hopkins (2016) indicated the importance of self-efficacy for mobile technology adoption from their study examining pre-service teachers' beliefs regarding using mobile technologies as a teaching or learning tool. Pre-service teachers with more exposure to various technologies in their education are likely to feel more confident using technology in their future classrooms (Burden et al., 2016:12).

Adequate training and professional development in technology integration proved that it could boost pre-service teachers' confidence in using technology effectively for teaching mathematics. Positive attitudes towards mathematics and technology also contribute to a greater belief in the potential of technology integration in teaching mathematics. Teacher preparation programs should consider providing hands-on experiences with technology, incorporating technology-rich coursework, offering relevant and effective professional development opportunities, and creating a positive and supportive learning environment that promotes the use of technology as a valuable tool in mathematics instruction to enhance pre-service teachers' self-efficacy for technology integration in mathematics. Additionally, mentorship and role modelling by experienced teachers and lecturers can also play a crucial role in building pre-service teachers' confidence in using technology effectively in the mathematics classroom.

### 4.3.3 Creating solid partnerships between TVET colleges and the Industry

Research findings proved that industry partnerships with TVET colleges and exposure to workplace-based training positively influence the employability of TVET graduates (UNESCO-UNEVOC, 2014). The TVET partnerships with industry have great potential to improve graduates' work-readiness (employability). Creating a solid partnership between TVET colleges and industry is crucial for both parties' success and the region's overall economic development. Such partnerships can bridge the gap between academic knowledge and practical skills required in the job market, leading to a more competent and job-ready workforce.

> **Thabo:** *"Presenting in class after teaching practice made it easy for me even with the use of a tablet."*
>
> **Tim:** *"The school where I did my teaching practice called me when they had a vacancy checking my availability."*

Based on the utterances above and discussions we had with pre-service teachers, it is evident that work-based learning is beneficial, and it allows pre-service teachers to apply theoretical knowledge gained in their coursework to real-world classroom situations. This bridge between theory and practice enhances their understanding of pedagogical concepts. Engaging in work-based learning encourages pre-service teachers to reflect on their teaching practices. Regular self-evaluation and feedback from mentor teachers contribute to continuous improvement.

### 4.3.4 Modifying the pre-service teachers' programme at TVET colleges

The criteria that define qualified teachers have completely changed; they are no longer limited to a teacher's content-specific and pedagogical knowledge. Instead, they went beyond that to technological know-how (Alhawiti, 2018:14). This claim is consistent with Mishra and Koehler's (2006) assertion that teachers must grasp more than the subject area they teach; they must also have a deep understanding of how the application of technology can change the subject matter. Khateeb (2021) stated that most pre-service teachers are not adequately digitally competent, as they do not match the standards of good digital teachers required for the twenty-first century.

Alzahrani (2021) suggested that training on technological tools and how to use them represent a crucial demand that TVET colleges must provide to their students,

particularly pre-service teachers. Nowadays, almost all teacher preparation programmes worldwide have technology training (Yüksel & Kavanoz, 2022). They at least provide one compulsory course in computer competency for undergraduate students. This approach would put new teachers in a better position than their predecessors. First, they would not have to change the teaching habits that they had built over a long period (Batane & Ngwako, 2021). Second, they would not have to face the difficulties and challenges their predecessors faced when they switched to digital education. Third, they would successfully create a rich learning environment and effective use of technology (Gibson, 2021:18).

Technology improves learners' achievement (Kaur, 2020:1) and assists them in accessing information, collaborating with others, communicating information, thinking creatively, expressing themselves, and constructing knowledge (Nath, 2022:12). Pre-service teachers may receive knowledge and skills of ICT; however, they lack confidence to implement them in a classroom setting, during the discussions with co-researchers it was evident that it is therefore imperative for TVET colleges to amend the curriculum in a way that it will best prepare the students for the working environment (Liu, 2022:8).

### 4.3.5 Aligning the National Certificate: Vocational (NCV) curriculum with the industry needs

Redesigning the TVET colleges to meet global skills needs necessitated changes in teaching and learning approaches (Sibisi, 2019:10). Lecturers had to adapt by embracing new teaching methods, accommodating diverse student groups, and taking on additional responsibilities. While change can be uncomfortable initially, with time and support, lecturers can effectively implement the changes and contribute to a more responsive and relevant TVET curriculum.

Many developed countries, including Turkey and technologically advanced countries like Kenya, have recognized the importance of TVET and have made efforts to improve and align the curriculum to the needs of the industry. One of the key areas of focus has been the development of occupational standards, which serve as a foundation for designing learning outcomes for vocational education (Ayaz et al., 2021:459). In South Africa, the Minister of Higher Education and Training, Prof. Blade Nzimande, has

mandated TVET colleges to introduce QCTO programs. The QCTO are occupational skills programs focused on practical, simulation and/or work experience. The main objective is to ensure certified students are more likely to secure employment or be employable.

The development of occupational standards includes defining the knowledge, skills, and competencies required for a specific occupation. These occupational standards are designed in collaboration with industry experts, potential employers, and relevant stakeholders to ensure that the TVET curriculum is aligned with the needs of the labour market. By having well-defined occupational standards, the curriculum can be tailored to address the real-world requirements of different industries and enhance the employability of TVET graduates (Ayaz et al., 2021:459-460). Additionally, the curriculum reform in TVET aims to update the content and teaching methods of vocational education. The reform process considers changes in technology, industry practices, and the evolving job market to ensure that TVET programs remain relevant and responsive to current and future workforce needs. This process may involve introducing new courses, incorporating technology-related skills, and promoting hands-on learning experiences to bridge the gap between theory and practice (Ayaz et al., 2021:460).

## 4.4 CONDITIONS CONDUCIVE TO EFFECTIVELY ENHANCE THE USE OF TABLETS IN TEACHING MATHEMATICS AMONG PRESERVICE TEACHERS

Conditions conducive to effective teaching of mathematics using tablet strategies among pre-service teachers are addressed, and it is crucial because failing to do so could hinder the successful cultivation approach from being implemented. The co-researchers felt it was important to outline conditions which were conducive to the implementation of the strategy. Accordingly, conditions that were believed to be conducive to the effective teaching of mathematics using tablets among pre-service teachers have been outlined below. The following conducive conditions are identified, namely (i) establishment of subject committees; (ii) pre-service teachers integrating technology when teaching mathematics; (iii) strong partnership between TVET

colleges and (iv) modification of pre-service teachers' programmes; and (v) aligning the NCV curriculum with the industry needs.

Several conducive conditions should be established to ensure the effective use of tablets to teach Grade R Mathematics among TVET pre-service teachers. These conditions are essential for creating a supportive and productive learning environment that maximizes the benefits of using tablets as educational tools.

TVET institutions should invest more in ensuring they have sufficient tablets and necessary infrastructure, such as reliable internet connectivity, to support technology integration in mathematics teaching. Each pre-service teacher should have access to a tablet during training to familiarize themselves with its functions and potential applications (Kirior, 2022:27). Furthermore, TVET colleges should provide comprehensive training and ongoing professional development sessions to pre-service teachers on how to effectively use tablets for teaching Grade R Mathematics. This training should cover various educational apps, interactive tools, and strategies for incorporating tablets into lesson plans.

In countries doing well in incorporating technological gadgets in education, an emphasis has been placed on integrating tablets as pedagogical tools, not just as standalone gadgets. Pre-service teachers have been taught how to align tablet activities with the learning objectives and curriculum requirements for Grade R Mathematics (Ngubane et al., 2020:11). Pre-service teachers should be prepared to use tablets for assessment purposes and not only for teaching the curriculum. Tablets can be powerful tools for collecting data, tracking student progress, and providing personalized feedback.

### 4.4.1 Conditions conducive to the establishment of subject committees

Subject committees will contribute positively to the training of pre-service teachers because they will assist them in broadening their scope in mathematics. Sharing good practices allows one to learn from each other (Mosia, 2016:137) by exploring diverse strategies. Pre-service teachers find a safe space when they are with their peers to communicate, share and address issues, observe one another's work and develop expertise in various aspects. Subject committees are necessary because they allow the nature of reality to be critically examined by intersubjective views; they also

strengthen competencies and promote collegiality while, on the other hand, reducing professional isolation and helping individuals to overcome weaknesses.

### 4.4.2 Conditions conducive to pre-service teachers integrating technology when teaching mathematics.

Pre-service teachers trained in pedagogical knowledge, content knowledge, and technological knowledge (TPACK) can teach mathematics effectively using tablets. They will be able to address the current skills shortages in the labour market and create a workforce for the future, whether as an academic subject geared toward intellectual development or simply as a necessary life skill.

### 4.4.3 Conditions conducive to solid partnerships between TVET colleges and the industry

Strengthening partnerships between TVET colleges and the industry will assist in placing more pre-service teachers for teaching practice. TVET colleges and industry partners should clearly understand shared goals and objectives so that the collaboration is purposeful and mutually beneficial. The placement of pre-service teachers in work-based learning will encourage them to reflect on their teaching practices. Regular self-evaluation and feedback from mentor teachers will contribute towards continuous improvement.

### 4.4.4 Conditions conducive to modification of pre-service teachers' programmes

Modifying the programs offered to pre-service teachers at TVET colleges will bring several benefits, positively impacting aspiring teachers and the education system. Modifications may focus on incorporating best practices in teaching, including using modern instructional methods, technology integration, and innovative approaches. This will contribute to the development of high-quality teachers.

### 4.4.5 Conditions conducive to aligning the National Certificate: Vocational (NCV) curriculum with the industry needs.

The aligned curriculum in TVET colleges will update the content and teaching methods of vocational education. The reform process considers changes in technology, industry practices, and the evolving job market to ensure that TVET programs remain relevant and responsive to current and future workforce needs. This process will involve incorporating technology-related skills and promoting hands-on learning experiences to bridge the gap between theory and practice (Ayaz et al., 2021:460).

## 4.5 ANTICIPATED THREATS AND HOW TO CIRCUMVENT THEM WHEN USING TABLETS FOR TEACHING AND LEARNING IN MATHEMATICS

When using tablets for teaching and learning mathematics, one may encounter several anticipated threats. It is essential to be aware of these threats and take proactive measures to circumvent them to ensure a successful implementation.

Tablets can be a source of distraction for learners, especially if they have access to non-educational apps or games. To circumvent this, teachers should implement clear rules and guidelines on tablet usage during mathematics lessons and use mobile device management (MDM) tools to restrict access to non-educational content during class time (Henry et al., 2018:23). Technical glitches, such as app malfunctions, battery drain, or internet connectivity problems, can disrupt the learning process. Teachers should perform regular maintenance on tablets, keep them charged, and have a backup plan in case of technical difficulties. They should also prepare alternative offline activities in case internet access is temporarily unavailable (Hu, 2022:12).

Relying too heavily on tablets may lead to neglecting other important teaching methods. Teachers should balance tablet-based activities and hands-on, collaborative, and interactive learning experiences. Some educational apps may not align perfectly with a particular school or region's specific curriculum or teaching approach. Teachers should be encouraged to customize and supplement tablet-based content to meet their students' needs and align with the prescribed curriculum.

## 4.6 SUCCESS INDICATORS OF THE STUDY EVIDENCE OF SUCCESSFUL CULTIVATION

This study will be deemed successful when the pre-service teachers can enhance the use of tablets when teaching Grade R mathematics, even during their presentations in class, when they demonstrate confidence and competence, when pre-service teachers can navigate the tablet's features effortlessly, seamlessly switching between educational apps, resources, and multimedia to enhance the mathematics lessons. Pre-service teachers should showcase effective pedagogical integration of tablets in their presentations, including using apps and tools that align with the learning objectives, engaging learners, and fostering critical thinking and problem-solving skills.

A successful enhancement will result in high levels of learner engagement. Learners should actively participate, interact with the tablet's content, and show enthusiasm for the mathematics lesson. The use of tablets during the presentation should contribute to clear learning outcomes. Learners should demonstrate an improved understanding of the mathematics concepts being taught.

Effective use of tablets should not disrupt classroom management. Pre-service teachers should be able to manage the use of tablets among learners efficiently, maintaining a positive and focused learning environment. Success will also be evident when pre-service teachers consistently incorporate tablet usage in their presentations and lesson plans rather than treating it as an isolated event.

This section offers potential evidence from the literature to provide conceptual direction on factual evidence and empirical data on the successful strategies of teaching mathematics using tablets among pre-service teachers. Disciplinary Learning in Mathematics using tablets; Morden Pedagogical Learning in teaching mathematics, WIL, Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics) and Situational learning (general classroom management when using tablets to teach mathematics) are examples of successful teaching practices.

### 4.6.1 Evidence of Disciplinary Learning in Mathematics using tablets

The evidence of disciplinary learning in mathematics using tablets is evident through various indicators and outcomes that demonstrate the integration of technology to

enhance learners' understanding and proficiency in mathematical concepts. Collectively, these types of evidence can offer a comprehensive view of disciplinary learning in mathematics using tablets, showcasing learners' understanding, application of concepts, and engagement in the learning process.

An adequate teacher professional development bears good result. If pre-service teachers are trained in pedagogical knowledge, content knowledge, and technological knowledge (TPACK), they can effectively teach mathematics. There is a need to support pre-service teachers' professional development in the domains of technology and pedagogy to improve the use of ICT in education. The training for pre-service teachers should create a workforce for the future and address the current skills shortages in the labour market. It is also an academic subject geared to intellectual development or simply a necessary life skill. The above alludes to the importance of professionally developed pre-service teachers.

### 4.6.2 Evidence of Morden Pedagogical Learning in teaching mathematics

Evidence of modern pedagogical learning in teaching mathematics can be seen when learners engage in inquiry-based learning activities to explore mathematical concepts through investigations, problem-solving, and asking questions independently or collaboratively. Learners working on authentic, real-world problems and projects in mathematics classrooms demonstrate the application of problem-based learning. Evidence includes learners presenting solutions, discussing approaches, and reflecting on the process.

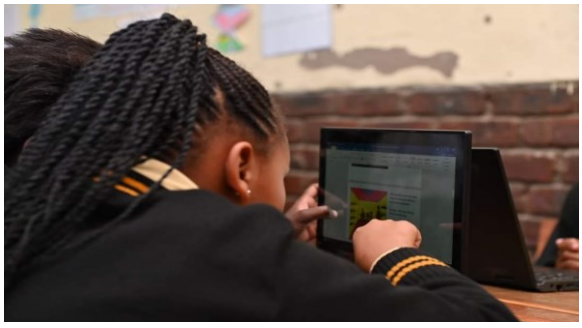


***Figure 4.4: Learners using tablets during a mathematics lesson.***

Observing learners working in groups, engaging in collaborative problem-solving, and participating in mathematical discussions provides evidence of modern pedagogical approaches emphasising social learning and teamwork. Learners take an active role

in their learning by making choices, setting goals, and participating in activities that cater to their interests and abilities. Pre-service teachers enjoyed offering lessons integrating technology in their classrooms and vowed to encourage their classmates to do the same.

### 4.6.3 Evidence of Work Integrated Learning (WIL) for pre-service teachers

Evidence includes pre-service teachers participating in professional development sessions organized by the co-researchers and schools where they complete their practicum. Attendance at workshops or training sessions demonstrates a commitment to continuous learning. Pre-service teachers were encouraged to attend all workshops and training programs at our meeting as we discussed the programs needed for training to capacitate them to be fully capacitated and upskilled in their field of work.

Pre-service teachers claimed that work-based learning enabled them to create connections and make plans that facilitated their achievement throughout the academic year. They had a chance to hear from a range of presenters and get first-hand experience with tools, software, and other resources that they utilize in the classroom (Boice, Jackson, Alemdar, Rao, Grossman & Usselman, 2021:8). These replies are positive and reflect the confidence some pre-service teachers believed they could teach mathematics using tablets without experiencing any challenges.

### 4.6.4 Evidence of Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics)

Using Information and Communication Technologies (ICT) in teaching mathematics is crucial for educators to enhance the learning experience and engage students in meaningful ways, which is evident because, during our observation, pre-service teachers proficient use of ICT involved creating interactive digital lessons, presentations, and multimedia content that effectively conveyed mathematical concepts. Pre-service teachers have proven their competence by being able to integrate specialized mathematical software into their teaching. These tools help visualize concepts, conduct experiments, and solve mathematical problems.

### 4.6.5 Evidence of situational learning (general classroom management when using tablets to teach mathematics)

During the observation sessions and discussions with co-researchers, it became evident that pre-service teachers had improved learners' behaviour in class by ensuring responsible tablet use, mainly if learners are not accustomed to using technology in the classroom. Pre-service teachers were also able to balance between digital and traditional instructional methods. They were also able to integrate tablets into the existing curriculum**.**

## 4.7 CHAPTER CONCLUSION

The design of a strategy for the effective teaching of mathematics using tablets among pre-service teachers at a TVET college in Gauteng was examined in this chapter, which also presented and interpreted the findings and conclusions of the data analysis. This was consistent with the study's goals listed in Chapter 1. Numerous data sources were used, including discussions held during co-researcher meetings when it was decided that creating a strategy was necessary. The information gathered revealed challenges to the effective teaching of mathematics using tablets. We discussed strategies for removing impediments to the effective teaching of mathematics using tablets. The team also considered the conditions required for the plan to be successful. Threats to the strategy's success were also foreseen. In contrast, our findings encourage us to further embrace the powerful, creative, and revolutionary possibilities of community classroom approach education for the preparation of pre-service teachers and development.

# CHAPTER 5
# SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

## 5.1 INTRODUCTION

The presentation, analysis, and interpretation of the data gathered using PAR in the preceding chapter were structured around the five study objectives. This study aimed to design a strategy to enhance the use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college. As a result, the summary of findings and discussions that emerged when the findings were compared to the literature reviewed for this study are presented. Further presentations of the debates are made about the theory and conceptual framework that served as the study's framework. After discussing the study's applicability, value, and limits, a synopsis of its methodology, a discussion of its findings, and some recommendations for further research are given.

## 5.2 FINDINGS AND DISCUSSIONS

The five study objectives served as a framework for the conclusions and discussions: an understanding of challenges experienced in enhancing the use of tablets in teaching Grade R mathematics among pre-service teachers at a TVET college, exploring the possible solutions to the mentioned challenges, investigating conducive conditions for those solutions, and anticipating potential threats to the emerging strategy and to mitigate them, as well as establishing possible ways or suggestions that propose effective strategy.

## 5.3 CHALLENGES THAT HINDER THE EFFECTIVENESS USE OF TABLETS IN TEACHING MATHEMATICS AMONG PRESERVICE TEACHERS AT A TVET COLLEGE

The primary findings for each issue will be presented in this section, along with recommendations that will help to accomplish the clarity and purpose of the study's five objectives.

### 5.3.1 Limited disciplinary learning in mathematics using tablets.

Previous research has proven that teachers with deep subject matter knowledge can explain complex mathematical concepts clearly and concisely. This was evident when the pre-service teachers and the co-researchers had their reflection meetings to reflect on the presented and observed lessons.

The pre-service teacher, Zaza, opted to use a traditional teaching method because she did not have in-depth mathematical knowledge and was unfamiliar with teaching mathematics using tablets. The pre-service teacher also opted to use a teacher-centred method, which does not benefit the learners. The learner-centred method actively involves learners in learning, making education more engaging. Learners are more likely to participate, ask questions, and take ownership of their learning.

Research has proven that pre-service teachers' programs must be aligned and strengthened to ensure that the pre-service teachers are experts in mathematics and can use technological tools when teaching mathematics. McGraw-Hill (2019) stated that (TPACK) theoretical framework has been developed to clarify and explain the set of knowledge that needs to be taught by pre-service teachers and to teach mathematics effectively using technology. TPACK is essential for pre-service teachers since they are the future educators expected to mould the new generation (Santos & Castro, 2021:2).

Considering the discussions, which were prompted by the research study's findings, the similarities between the research findings of the other studies that were reviewed, and the lack of disciplinary learning in mathematics using tablets and the traditional method of teaching, The theoretical framework and conceptual framework, which assisted in the creation of the study's framework, provided additional support for this strategy. Therefore, pre-service teachers must be specialists in their subjects and ensure they choose the correct teaching methods (cf. 4.3.1).

#### *5.3.1.1 Recommended strategies to establish the subject committees to strengthen the content knowledge of pre-service teachers.*

Teams strengthen competencies and promote collegiality while, on the other hand, reducing professional isolation and helping individuals to overcome weaknesses. The pre-service teachers were capacitated with the correct content knowledge and

teaching methods. The sessions were conducted by lecturers, teachers, and university pre-service teachers (cf. 4.4.1). Different teaching strategies were discussed to make teaching and learning mathematics using tablets fun and effective. The co-researchers from the local university attested to the PAR methodology. They came to the college to share knowledge with pre-service teachers on how best to incorporate technology when teaching mathematics. From that engagement, pre-service teachers gained confidence in conducting mathematics lessons using tablets.

The study recommends that the effective teaching of mathematics using tablets depends on strengthening the mathematical content of pre-service teachers and the correct application of TPACK in all lesson presentations, enabling the pre-service teachers to teach mathematics effectively using tablets, resulting in learners gaining the necessary skills that will allow them to face the evolving world.

### 5.3.2 Lack of modern pedagogical learning in teaching mathematics

The study showed that pre-service teachers struggle to integrate modern pedagogical learning in teaching mathematics. Previous research has proven that a lack of pedagogical learning in teaching mathematics with tablets hinders a dynamic, interactive, and learner-centred learning environment. Pre-service teachers must be given the skills to leverage technology effectively, promoting more profound understanding, engagement, and overall positive learning outcomes in mathematics education (Naomi et al., 2016:124).

#### *5.3.2.1 Recommended strategies for self-efficacy to technology integration*

The study revealed that self-efficacy for technology integration is an essential factor influencing pre-service teachers' actual use, acceptance, and adoption of technology in teaching. It also builds confidence in their capabilities to incorporate technology into teaching to facilitate learning successfully (Hur et al., 2015:17). It has been proven that pre-service teachers with higher levels of technology integration self-efficacy are more open to new ideas, strategies, and experiments for incorporating technology to create learning opportunities, and are more willing to put forth continuous efforts to tasks that involve the use of technology.

This study recommends that pre-service teachers be given adequate training and professional development in technology integration to boost their confidence in using technology effectively for teaching mathematics. They will also have a positive attitude towards mathematics and technology and contribute to a greater belief in the potential of technology integration in teaching mathematics.

### 5.3.3 Inadequate Work-Integrated Learning (WIL)

WIL experiences for pre-service teachers in mathematics provide a bridge between theory and practice. These experiences are essential in shaping effective and culturally responsive teachers, ensuring they are well-prepared to meet the diverse needs of learners in natural classroom settings.

WIL aims to give pre-service teachers expanded opportunities to enhance their skills in using modern teaching strategies, including technological tools like tablets when teaching mathematics. The study revealed that when pre-service teachers were given adequate time for teaching practice, it allowed them to identify and address challenges and barriers that hindered effective ways of using tablets in the mathematics classroom (Ngubane et al., 2020:7). Furthermore, providing pre-service teachers with substantial teaching practice using tablets ensured that they are well-prepared to use technology effectively and creatively in their future classrooms (Moreno, 2022:724).

#### *5.3.3.1 Recommended strategies to Create a strong partnership between TVET colleges and the industry.*

It is evident that work-based learning is beneficial, allowing pre-service teachers to apply theoretical knowledge gained in their coursework to real-world classroom situations. This bridge between theory and practice enhances their understanding of pedagogical concepts. Engaging in work-based learning encourages pre-service teachers to reflect on their teaching practices. Regular self-evaluation and feedback from mentor teachers contribute to continuous improvement. This study, therefore, recommends that TVET colleges solidify their relationships with potential employers so that students can gain the required experience.

### 5.3.4 Fundamental learning (the ability to use ICTs in teaching Mathematics)

Nowadays, almost all teacher preparation programmes worldwide offer technology training (Yüksel & Kavanoz, 2022). They provide one compulsory course in computer competency for undergraduate students. This approach has put pre-service teachers in a better position than their predecessors. Pre-service teachers do not have to change the teaching habits built over a long period (Batane & Ngwako, 2021). They also do not have to face the difficulties and challenges their predecessors faced when they switched to digital education. They can successfully create a rich learning environment and effectively use technology (Gibson, 2021:18).

#### *5.3.4.1 Recommended strategies to modify the pre-service teachers' programme at TVET colleges.*

It has been evident that pre-service teachers' proficient use of ICT involved creating interactive digital lessons, presentations, and multimedia content that effectively conveyed mathematical concepts. Pre-service teachers have proven their competence by being able to integrate specialized mathematical software into their teaching. These tools help visualize concepts, conduct experiments, and solve mathematical problems. It is recommended that teachers' programs offer a detailed program in ICT that will enable students to broaden their presentation skills when teaching mathematics using technology.

### 5.3.5 Challenges in situational learning (general classroom management when using tablets to teach mathematics)

Situational learning focuses on real-life experiences and encourages learners to apply their knowledge and skills in specific, authentic situations. It also involves problem-solving, critical thinking, and the practical application of concepts to address challenges or tasks relevant to a particular context. During the observation sessions, it became evident that pre-service teachers can now deal with learners’ behaviour in class and ensure responsible tablets, mainly if learners are not accustomed to using technology in the classroom.

#### *5.3.5.1 Recommended strategies to align the National Certificate: Vocational (NCV) curriculum with the industry needs.*

The findings have revealed that pre-service teachers have gained in-depth content knowledge and are now confident to deliver lessons using technological devices, including tablets. They are also able to balance between the traditional methods and the new ways of teaching. This study further recommends that the NCV curriculum be broadened and more relevant to the industry.

## 5.4 STRATEGY FOR THE EFFECTIVE TEACHING OF MATHEMATICS USING TABLETS

The study is about the effective teaching of mathematics using tablets among pre-service teachers at a TVET college. Effective teaching of mathematics using tablets involves a variety of teaching strategies, such as using educational apps and explaining instructions on how to solve mathematical problems. Pre-service teachers have limited disciplinary learning in Mathematics using tablets, lack of Morden pedagogical learning in teaching mathematics, inadequate WIL, fundamental learning (The ability to use Information and Communication Technologies in teaching Mathematics), and challenges in situational learning (general classroom management when using tablets to teach mathematics) were the identified as hindrances that prevent the success of the strategy. The conditions for the strategy's success were investigated, and the success indicators influenced the strategy's success.

### 5.4.1 Background to the strategy

The study revealed that pre-service teachers did not have enough content and did not have the correct method of teaching mathematics with tablets. This was shown during the co-researchers' first discussion meeting of their action plan. The lack of effective mathematics teaching using tablets became evident when pre-service teachers could not use technology during their teaching practice and opted for traditional methods. Ineffective teaching of mathematics among pre-service teachers due to their lack of content and pedagogical expertise emerged as the main challenge to the strategy's effectiveness. The strategy includes these attributes because they include pre-service teachers who lack both content and pedagogical content knowledge. The key to

designing an effective strategy for teaching mathematics using tablets among pre-service teachers is that they must be properly trained and given support from the college and the department of education.

## 5.5 RELEVANCE OF THE STUDY

The study is relevant to the enhancing of the use of tablets in teaching Grade R mathematics mong ECD pre-service teachers at a TVET college. The study may assist in teaching mathematics using tablets effectively and encourage some better ways of teaching mathematics to reach success. The study is relevant for guiding and preparing pre-service teachers and learners to solve problems, think critically, and work collaboratively and creatively while functioning in a digital and information-driven world (Brown, Neal & Fine, 2011:21). Digital and ICT skills are essential and must be applied and transferred to solve daily mathematical problems, recognise possibilities, and include equipping learners for meaningful and successful living in an evolving world. Hence, the research emphasises the importance of learning and teaching mathematics (Hu, 2022:11).

## 5.6 THE VALUE OF THE STUDY

This study will help pre-service teachers effectively use tablets to teach mathematics in Grade R. It will help improve the pedagogical skills of TVET pre-service teachers. School principals, management teams, TVET college lecturers and DHET officials can use the information gathered in this study to support and provide relevant ICT tools and training for pre-service teachers and teachers already in the system. School management teams and principals can build solid and productive relationships with TVET college lectures with an understanding that the TVET sector is not an isolated component of the education system. Still, part of it will assist in providing better education for the learners.

This study is significant because it provides strategies for teaching mathematics using tablets effectively among Grade R pre-service teachers at a TVET college. The pre-service teachers had an opportunity to deliver mathematical lessons using tablets effectively. This study was helpful for pre-service teachers, learners, and lecturers. This study was further beneficial to the TVET college policy makers and curriculum

developers to develop quality training material that will strengthen students' disciplinary learning and their pedagogical learning.

This study is relevant because it guides and prepares pre-service teachers to deliver lessons that will enable learners to solve problems, think critically, work collaboratively and creatively, function in a digital and information-driven world, apply digital and ICT skills, and transfer these skills to solve everyday problems and its possibilities, including equipping learners for meaningful and successful living in a rapidly evolving society (DBE, 2018:12).

PAR encourages all participants, recognised as co-researchers, to contribute to the problem-solving process, regardless of whether the lessons are practical (Nhlapho, 2021:24).

The purpose was to ensure that pre-service teachers and the rest of the team members reflected on the strategies used when the lessons were presented, regardless of whether they were successful. The study's main aim was: “How to enhance the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at TVET college?” and to answer the five questions to achieve the five objectives of the study. What triggered this study was the importance of the skills needed in the changing, technological world.

This study wants to prove that pre-service teachers can teach mathematics effectively using technological tools, provided they are being appropriately trained and given support. Based on the literature review in Chapter 2, we have looked at developed countries, specifically Turkey, Kenya, and South Africa, to see how the relevance of the curriculum at college benefits the students during their teaching practice and prepares them to be well-equipped teachers. Research shows that many countries have integrated technology into their teaching programmes to ensure that pre-service teachers not only master the curriculum but also master the usage of technological tools in their lessons (Rich et al., 2018:316).

## 5.7 SUCCESSES IN DESIGNING THE STRATEGY

The success of designing a strategy for effective teaching of mathematics using tablets among ECD pre-service teachers at a TVET college was indicated by using the correct teaching method, which was learner-centred and allowed learners to participate fully

in the learning process. Pre-service teachers know the importance of mastering the subjects they specialise in and integrating technology in their classrooms so that their lessons can be interactive.

Developing a strategy for the successful teaching of mathematics using tablets might result from the collective responsibility between the pre-service teachers and all other stakeholders. Adequate teacher training and professional development benefited the pre-service teachers in effectively teaching mathematics using tablets and imparting the knowledge that will cause the learners to achieve the intended outcomes, surviving in the technological world. Furthermore, pre-service teachers benefited by delivering engaging and interactive lessons and designing activities that enable learners to use critical thinking, computational thinking, algorithm thinking, and problem-solving skills (DBE, 2021:20).

## 5.8 METHODOLOGICAL CONTRIBUTIONS

PAR was used as a methodological strategy for this study. PAR is a research approach that prioritizes the involvement of those directly impacted by a problem in the research process. PAR is based on the belief that those directly affected by a problem or issue are best equipped to understand it and propose effective solutions. It seeks to empower co-researchers to engage in research actively (cf. 3.2.1).

In PAR, the researcher takes on a facilitative role rather than a controlling role. The researcher does not impose a predetermined agenda or solutions but collaborates with co-researchers to identify relevant research questions and methodologies. The needs and perspectives of the participants drive the research topic and design. The main goal is to address pertinent and significant issues to the community or individuals involved.

PAR values the first-hand knowledge and experiences of co-researchers and actively involves them in all stages of the research, from problem identification to action planning and evaluation. PAR recognizes that co-researchers can learn valuable information while actively engaging in research. This experiential learning can foster unexpected creativity and insights that may not have been apparent through traditional research approaches (Raynor, 2019:131). PAR is a dynamic and inclusive approach that seeks to address social problems and promote positive change through

collaboration, shared learning, and the active involvement of those most affected by the studied issues.

## 5.9 LIMITATIONS OF THE STUDY

Only one campus in Gauteng is covered by the study. The generalisation of the study results is limited due to the number of offered campuses. The non-cooperation of the curriculum and assessment unit from the head office to advise and give training in other teaching and assessing mathematics topics.

Therefore, it was impossible to share the opinions, expertise, experience, and skills of curriculum implementers from the head office to enrich the study with a wide range of data as desired. Acknowledgement is made about being limited, as we have applied Van Dijk while analysing the data gathered on interpreted and explaining enacted disparities and domination through text and voice, as well as through social change and empowering (Van Dijk, 2001:352). One of the primary goals of teaching mathematics to learners is to create power relations so that they can do better in the future, be critical thinkers and problem solvers, and be confident and creative.

We acknowledge that this cannot be achieved in one study. More data collected using PAR should allow a deeper understanding of the potential impact of a teacher training programme on teaching mathematics using technological tools. In addition, the research-based design of the study investigating engagement can guide future research examining the impact of effective teaching and learning of mathematics using technology.

We cannot, however, assert that our findings are generally relevant at this point in the research process. However, the primary goal of our research was to design a strategy based on the most recent work about the effective use of tablets in teaching mathematics by pre-service teachers rather than statistically generalisable conclusions. Future studies should consider a follow-up of all the challenges that make it difficult for pre-service teachers to teach mathematics effectively using tablets in Grade R by looking at other strategies that will help to evaluate the implementation of the strategy.

## 5.10 SUMMARY OF THE STRATEGY

The study demonstrates the necessity of encouraging pre-service teachers to use modern pedagogical methods when teaching mathematics. It is suggested that all stakeholders determine, assess, evaluate, and address a particular challenge. In all the challenges identified, PAR plays an essential role in bringing about positive classroom changes through a framework that assists in designing an effective strategy for teaching mathematics using tablets since it involves all team members and stakeholders participating wholeheartedly, willingly discussing, and solving the challenges and help in the teaching of mathematics effectively.

The study argues that challenges hinder the effective teaching of mathematics using tablets by pre-service teachers, and, in turn, many strategies have been initiated and employed. Hence, in this study, PAR's purpose was to effectively provide pre-service teachers with valuable solutions to their problems in teaching mathematics.

## 5.11 CONCLUSION

Effective teaching of mathematics using tablets among Grade R pre-service teachers prepares them to be competitive in the 21st century. This is evident when the pre-service teachers use modern pedagogical methods when conducting lessons. In teaching mathematics, learners and pre-service teachers acquire certain skills, like critical thinking, algorithm thinking, and problem-solving skills.

However, some challenges hinder the effective teaching of mathematics using tablets, such as (i) Limited Disciplinary Learning in Mathematics using tablets, (ii) Lack of Morden Pedagogical Learning in teaching mathematics, (iii) Inadequate WIL, (iv) Fundamental Learning (The ability to use Information and Communication Technologies in teaching Mathematics) and (v) Challenges in Situational learning (general classroom management when using tablets to teach mathematics). We believe that more attention must be given to pre-service teachers to ensure they are well-equipped and can teach the mathematical content using technological tools. Furthermore, the focus should not only be on humans; non-human variables also significantly impact how effectively mathematics can be taught. To address all the challenges mentioned in this study, which hinder the effective teaching of mathematics using tablets among Grade R pre-service teachers, a TVET college in Gauteng should

make resources available to eliminate these challenges that the pre-service teachers face.

## REFERENCES


Abdulla, M. and Ma, W., 2022. Remote teaching and learning in applied engineering: A post-pandemic perspective. In Applied Degree Education and the Future of Learning (pp. 167-182). Singapore: Springer Nature Singapore.

Abrahamson, D., 2021. Grasp actually: An evolutionist argument for enactivist mathematics education. *Human Development*, *65*(2), pp.77-93.

Abrami, P.C., Wade, C.A., Lysenko, L., Marsh, J. and Gioko, A., 2016. Using educational technology to develop early literacy skills in Sub-Saharan Africa. *Education and Information Technologies*, *21*, pp.945-964.

Aktürk, A.A. and Demircan, O., 2017. A review of studies on STEM and STEAM education in early childhood. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD)*, *18*(2), pp.757-776.

Alaimo, S., 2016. *Exposed: Environmental politics and pleasures in posthuman times*. U of Minnesota Press.

Alhawiti, M.M.E., Alzhrani, L.D.G., Aljohani, A.A., Alhawiti, R.M.E., Alatwi, G.E., Asiri, R.T., Saud, R., Albalawi, A. and Alatawi, Z., PREVALENCE OF VISUAL DEFECTS RELATED TO DIGITAL DEVICE USAGE OF EDUCATIONAL PURPOSE AMONG UNIVERSITY OF TABUK STUDENTS, SAUDI ARABIA, 2020.

Allais, S., Schoer, V., Marock, C., Kgalema, V., Ramulongo, N. and Sibiya, T., 2021. Rethinking 'supply and demand'of technical and vocational education and training: insights from a company survey in three manufacturing sectors in South Africa. *Journal of Education and Work*, *34*(5-6), pp.649-662.

Al-Sharef, T. 2018. *Pre-Service Teachers' Perceptions of the Barriers to ICT Integration in Their Future Instructional Practice in a Gulf State* (Doctoral dissertation). The University of Liverpool.

Alzahrani, B., Bahaitham, H., Andejany, M. and Elshennawy, A., 2021. How ready is higher education for quality 4.0 transformation according to the LNS research framework? *Sustainability*, *13*(9), p.5169.

Anderson, S.E. and Maninger, R.M. 2007. Preservice teachers' abilities, beliefs, and intentions regarding technology integration. *Journal of Educational Computing Research*, 37(2), pp.151-172.

Anthony, G. and Walshaw, M. 2009. Characteristics of effective teaching of mathematics: A view from the West. *Journal of Mathematics Education*, 2(2), pp.147-164.

Arfo, E.B., 2015. *A comparative analysis of Technical and Vocational Education and Training policy in selected African countries* (Doctoral dissertation).

Attard et al., 2014

Avcu, R., 2019. A comparison of mathematical features of Turkish and American textbook definitions regarding special quadrilaterals. *International Journal of Mathematical Education in Science and Technology*, *50*(4), pp.577-602.

Ayaz-Alkaya, S and. Kacar, D., 2022. The effect of traditional children's games on internet addiction, social skills and stress level. *Archives of Psychiatric Nursing*, *40*, pp.50-55.

Bakar, N.S.A., Maat, S.M. and Rosli, R. 2020. Mathematics Teacher's Self-Efficacy of Technology Integration and Technological Pedagogical Content Knowledge. *Journal on Mathematics Education*, 11(2), pp.259-276.

Balakrishna, V. and Claiborne, L. 2017. Participatory Action Research in Culturally Complex Societies: Opportunities and Challenges. *Educational Action Research,* 25(2), pp.185-202.

Ball, D.L. and Cohen, D.K. 1996. Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25(9), pp.6-14.

Barad, K., 2007. *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. duke university Press.

Batane, T., and Kgwefane, T. 2021. Factors influencing school management teams in implementing ICT policy in Botswana schools. *International Journal of Innovation in Education*, *7*(1), pp.27-46.

Bayne, S. 2018. Posthumanism: A navigation aid for educators on education. *Journal for Research and Debate*, 2(1), pp.1-7.

Bayram, I. and Baturay, M.H., 2022. Pre-Service EFL Teachers' Perceptions of Online Instructional Tools. *Journal of English Teaching*, *8*(1), pp.84-96.

Bennett, S. and Maton, K., 2010. Beyond the 'digital natives' debate: Towards a more nuanced understanding of students' technology experiences. *Journal of computer assisted learning*, *26*(5), pp.321-331.

Bijker, W.E. and Law, J. eds., 1994. *Shaping technology/building society: Studies in sociotechnical change*. MIT press.

Blaikie, F., Daigle, C. and Vasseur, L. 2020. *New pathways for teaching and learning: The posthumanist approach.* Available from https://dr.library.brocku.ca/handle/10464/15047 [accessed 15 Jan. 2024].

Boice, K.L., Jackson, J.R., Alemdar, M., Rao, A.E., Grossman, S. and Usselman, M. 2021. Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program. *Education Sciences*, 11(3), p.105.

Braidotti, R. 2013. Posthuman humanities. *European Educational Research Journal*, 12(1), pp.1-19.

Brown, C.A., Neal, R.E. and Fine, B. 2011. Using 21st century thinking skills applied to the TPACK instructional model. *Annual Meeting of the AECT International Convention, Hyatt Regency Jacksonville Riverfront, Jacksonville, FL* (pp. 21-28).

Bruzzone, S., 2021. A posthumanist research agenda on sustainable and responsible management education after the pandemic. *Journal of Global Responsibility*, *13*(1), pp.56-71.

Burden, K. and Hopkins, P., 2017. Barriers and challenges facing pre-service teachers use of mobile technologies for teaching and learning. In *Blended learning: Concepts, methodologies, tools, and applications* (pp. 1665-1686). IGI Global.

Burden, K., Aubusson, P., Brindley, S. and Schuck, S., 2016. Changing knowledge, changing technology: implications for teacher education futures. *Journal of Education for Teaching*, *42*(1), pp.4-16.

Cathy, C. and Jace, H., 2018. Mobile learning transformation in a national higher education system. In *Mobile Learning And Higher Education* (pp. 126-135). Routledge.

Chandler, L.K., Cochran, D.C., Christensen, K.A., Dinnebeil, L.A., Gallagher, P.A., Lifter, K., Stayton, V.D. and Spino, M., 2012. The alignment of CEC/DEC and NAEYC personnel preparation standards. *Topics in Early Childhood Special Education*, *32*(1), pp.52-63. Naomi et al., 2016.

Chang, A., Jeske, L., Ulbrich, S., Hofmann, J., Koblitz, J., Schomburg, I., Neumann-Schaal, M., Jahn, D. and Schomburg, D., 2021. BRENDA, the ELIXIR core data resource in 2021: new developments and updates. *Nucleic acids research*, *49*(D1), pp. D498-D508.

Cielemęcka, O. and Daigle, C. 2019. Posthuman sustainability: An ethos for our anthropocenic future. *Theory, Culture & Society*, 36(7-8), pp.67-87.

Coole, D. and Frost, S. 2010. *New materialisms: Ontology, agency, and politics*. London: Duke University Press.

Copur-Gencturk, Y. and Tolar, T. 2022. Mathematics teaching expertise: A study of the dimensionality of content knowledge, pedagogical content knowledge, and content-specific noticing skills. *Teaching and Teacher Education*, 114, p.103696.

Dandar, D. and Lacey, S. 2021. Critical Discourse Analysis as a Reflection Tool for Information Literacy Instruction: A Case Study Approach of Library Orientation Sessions. *Journal of Information Literacy*, 15(1), pp.3-25.

Department of Basic Education (DBE). 2011. *Curriculum and Assessment Policy Statement (CAPS). Foundation Phase: Grades 1-3.* Pretoria: Government Printer.

Department of Basic Education (DBE). 2016. Personnel Administrative Measures (PAM). Pretoria; Department of Basic Education.

Department of Basic Education (DBE). 2018. The South African CURRICULUM AND ASSESSMENT POLICY STATEMENT (CAPS)for CODING AND ROBOTICS GRADES R- 9. Pretoria: Department of Basic Education

Department of Basic Education (DBE). 2021. ECD Census 2021: Report. Pretoria: Department of Basic Education

Department of Higher Education & Training (DHET). 2011. *Minimum Requirements for Teacher Education Qualifications (MRTEQ) Policy.* Pretoria: Government Printer.

Dewa, A. and Ndlovu, N.S., 2022. Use of information and communication technologies in mathematics education lecturers: Implications for pre-service teachers. *Journal for Transdisciplinary Research in Southern Africa*, 18(1), pp.1-8.

Dlamini, M.E. 2018. Preparing student teachers for teaching in rural schools using work integrated learning. The Independent Journal of Teaching and Learning, 13(1) 86-96.

Dreyer, L.M., 2017. Constraints to quality education and support for all: A Western Cape case. *South African Journal of Education*, *37*(1).

Dube, B. 2020. Rural Online Learning in the Context of Covid-19 in South Africa: Evoking an Inclusive Education Approach. *Multidisciplinary Journal of Educational Research,* 10(2), pp.135-157.

Evens, M., Elen, J. and Depaepe, F., 2015. Developing pedagogical content knowledge: Lessons learned from intervention studies. *Education Research International*, *2015*. https://doi.org/10.1155/2015/790417

Fairleigh Dickinson University Press Raphael, M.L., 1995. Mark K. Bauman. Harry H. Epstein and the Rabbinate as Conduit for Change. Cranbury, NJ: Fairleigh Dickinson University Press. 1994. Pp. 160.

Lorenzo-Seva, U. and Ferrando, P.J., 2013. FACTOR 9.2: A comprehensive program for fitting exploratory and semi confirmatory factor analysis and IRT models. *Applied psychological measurement*, *37*(6), pp.497-498.

Ferrando, I.N., and García, C.G. 2014. Digital literacy and metaphorical models. *Multidisciplinary Journal for Education, Social and Technological Sciences*, *1*(2), pp.160-180.

Ferrer-Estévez, M. and Chalmeta, R., 2021. Integrating sustainable development goals in educational institutions. *The International Journal of Management Education*, 19(2), p.100494.

Galletta, A. and Torre, M.E. 2019. *Participatory action research in education.* Available from https://oxfordre.com/education/view/10.1093/acrefore/9780190264093.001.0001/acrefore-9780190264093-e-557?print=pdf [accessed 28 Oct 2021].

García-Peñalvo, F.J., 2016. The WYRED project: A technological platform for a generative research and dialogue about youth perspectives and interests in digital society.

George, G., Dilworth-Bart, J. and Herringa, R., 2021. Potential socioeconomic effects of the COVID-19 pandemic on neural development, mental health, and K-12 educational achievement. *Policy insights from the behavioral and brain sciences*, *8*(2), pp.111-118.

Gibson, I., Rosen, D.W., Stucker, B., Khorasani, M., Rosen, D., Stucker, B. and Khorasani, M., 2021. *Additive manufacturing technologies* (Vol. 17, pp. 160-186). Cham, Switzerland: Springer.

Green, H.E., 2014. Use of theoretical and conceptual frameworks in qualitative research. *Nurse researcher*, *21*(6).

Habibie, P., 2016. Writing for scholarly publication in a Canadian higher education context: A case study. In *Research literacies and writing pedagogies for master's and doctoral writers* (pp. 51-67). Brill.

Halliday, A.J., Kern, M.L., Garrett, D.K. and Turnbull, D.A., 2019. The student voice in well-being: A case study of participatory action research in positive education. *Educational Action Research*, *27*(2), pp.173-196.

Harris, A. and Jones, M., 2018. Why context matters: A comparative perspective on education reform and policy implementation. *Educational Research for Policy and Practice*, *17*, pp.195-207.

Hassan, I. 1977. Prometheus as performer: Toward a posthumanist culture. *The Georgia Review*, 31(4), pp.830-850.

Hauk, S., Toney, A., Jackson, B., Nair, R. and Tsay, J.J., 2014. Developing a Model of Pedagogical Content Knowledge for Secondary and Post-Secondary Mathematics Instruction. *Dialogic Pedagogy*, *2*.

Hechter, R.P., Phyfe, L.D. and Vermette, L.A. 2012. Integrating technology in education: moving the TPCK framework towards practical applications. *Education Research and Perspectives*, 39(1).136-152.

Henry, M., 2020. Online student expectations: A multifaceted, student-centred understanding of online education. *Student Success*, *11*(2), pp.91-98.

Holmes, Richard B. *Geometric functional analysis and its applications*. Vol. 24. Springer Science & Business Media, 2012.

Hoover, J.J. and DeBettencourt, L.U., 2018. Educating culturally and linguistically diverse exceptional learners: The need for continued advocacy. *Exceptionality*, *26*(3), pp.176-189.

Hu, Y.H., 2022. Effects of the COVID-19 pandemic on the online learning behaviours of university students in Taiwan. *Education and Information Technologies*, *27*(1), pp.469-491.

Hur, J.W., Shen, Y.W., Kale, U. and Cullen, T.A., 2015. An exploration of pre-service teachers' intention to use mobile devices for teaching. *International Journal of Mobile and Blended Learning (IJMBL)*, *7*(3), pp.1-17.

Hurrel, S., Scholarios, D. and Thompson, P., 2013. More than a'Humpty Dumpty Word': An Exploration of the Status of Soft Skills. *Economic and Industrial Democracy*, *1*(34),.161-182.

Ibeawuchi, E.O., 2010. *The role of pedagogical content knowledge in the learning of quadratic functions* (Doctoral dissertation, University of South Africa).

Ishenyi, P.M and Chebet, W, 2023. household-related factors leading to students' dropout from mixed-day secondary schools in Bomet East Sub-County, Kenya. *Sch J Arts Humanit Soc Sci*, *7*,.187-191.

Jacobs, S., 2016. The Use of Participatory Action Research within Education--Benefits to Stakeholders. *World Journal of Education*, *6*(3), pp.48-55.

Jahedi, M., Abdullah, F.S. and Mukundan, J. 2014. An overview of focal approaches of critical discourse analysis. *International Journal of Education and Literacy Studies*, 2(4), pp.28-35.

James, D., Shaw, S. Fitzsimons, P., and Newcombe, B., 2022. Drivers of activity in children's social care. *Department for Education*.

Jojo, Z. 2019. Mathematics education system in South Africa. *Education Systems Around the World*. Intech Open. https://doi.org/10.5772/intechopen.85325

Kaur, N., Dwivedi, D., Arora, J. and Gandhi, A., 2020. Study of the effectiveness of e-learning to conventional teaching in medical undergraduates amid COVID-19

pandemic. *National Journal of Physiology, Pharmacy and Pharmacology*, *10*(7), .563-567.

Kaushik, D., Hovy, E. and Lipton, Z.C., 2019. Learning the difference that makes a difference with counterfactually augmented data. *arXiv preprint arXiv:1909.12434*.

Khateeb, L.A., Shdaifat, S.A.K. and Shdaifa, N.A., 2021. Effectiveness of Communication Techniques in Distance Education and Its Impact on Learning Outcomes at Jordanian Universities (Northern Province). *International Journal of Higher Education*, *10*(2), pp.74-82.

Kilpatrick, J., Swafford, J. and Findell, B. 2001. *Adding it up: Helping children learn mathematics* (Vol. 2101). Washington, DC: National Academy Press.

Kirior, H. 2017. Improving the TVET Curriculum as a Strategy for Better Performance. *Africa Journal of Technical & Vocational Education & Training*, 2(1), pp.22-30.

Knackendoffel, E.A. 2007. Collaborative teaming in the secondary school. *Focus on Exceptional Children*, 40(4), p.1.

Koehler, M. and Mishra, P. 2009. What is technological pedagogical content knowledge (TPACK) *Contemporary Issues in Technology and Teacher Education*, *9*(1), .60-70.

Kristianto, H. and Gandajaya, L., 2023. Offline vs online problem-based learning: A case study of student engagement and learning outcomes. *Interactive Technology and Smart Education*, *20*(1), pp.106-121.

Kruger, J.L. and Doherty, S., 2016. Measuring cognitive load in the presence of educational video: Towards a multimodal methodology. *Australasian Journal of Educational Technology*, *32*(6).

Kurt, S., 2018. Moving toward a universally accessible web: Web accessibility and education. Assistive Technology.

Kwong, C.W., Joseph, Y.K.K., Eric, C.C.M., Khoh, L.T.S., Gek, C.K. and Eng, N.L., 2007. Development of mathematics pedagogical content knowledge in student teachers. *The Mathematics Educator*, *10*(2), 27-54.

Leotti, S.M., Sugrue, E.P. and Winges-Yanez, N. 2021. Unpacking the worlds in our words: Critical discourse analysis and social work inquiry. *Qualitative Social Work*, p.1473325021990860. https://doi.org/10.1177/1473325021990860

Lestari, N.N. and Indrasari, S.Y. 2019. Teachers' adoption of 1: 1 iPad implementation in the classroom: The role of efficacy and perceived impact. *Interactive Technology and Smart Education*, 16(3), pp.278-299.

Letts, W. and Sandlin, J.A. 2013. Editors' Introduction: Glass walls, cages, and paws—A "brood of researchers" engages a posthumanist politics of sight. *Journal of Curriculum and Pedagogy*, 10(1), pp.1-3.

Liu, Y. and Pásztor, A., 2022. Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*, *45*, .101069.

Loewenberg Ball, D., Thames, M.H. and Phelps, G., 2008. Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), pp.389-407.

MacDonald, C. 2012. Understanding participatory action research: A qualitative research methodology option. *The Canadian Journal of Action Research*, 13(2), pp.34-50.

Magunje, C. and Chigona, A. 2021. E-Learning Policy and Technology-Enhanced Flexible Curriculum Delivery in Developing Contexts: A Critical Discourse Analysis. *Critical Studies in Teaching and Learning (CriSTaL)*, 9(2), pp.83-104.

Mahlomaholo, M.G. 2012. Social communication towards sustainable physical science learning environments. *Communitas,* 17, pp.3-20.

Makgato, M. and Moila, O. 2019. Partnerships between TVET colleges and industry to enhance work-related skills. *World Transactions on Engineering and Technology Education*, 17(3), pp.332-337.

Makonye, J.P. 2017. Pre-service mathematics student teachers' conceptions of nominal and effective interest rates. *Pythagoras*, 38(1), pp.1-10.

Marks, R. 1990. Pedagogical content knowledge: From a mathematical case to a modified c Allais, S., Schoer, V., Marock, C., Kgalema, V., Ramulongo, N. and Sibiya, T., 2021. Rethinking 'supply and demand'of technical and vocational education and training: insights from a company survey in three manufacturing sectors in South

Africa. *Journal of Education and Work*, *34*(5-6), pp.649-662.onception. *Journal of Teacher Education*, 41(3), 3-11.

Marquez, B., VinCent, C., Marquez, J., Pennefather, J., Smolkowski, K. and Sprague, J. 2016. Opportunities and challenges in training elementary school teachers in classroom management: Initial results from classroom management in action, an online professional development program. *Journal of Technology and Teacher Education*, *24*(1), pp.87-109.

Marsh, J., 2016. The digital literacy skills and competences of children of pre-school age. *Media education*, *7*(2), pp.178-195.

Marsh, C., Schindler, L.A., Burkholder, G.J., and Morad, O.A. 2017. Computer-based technology and student engagement: a critical review of the literature. *International journal of educational technology in higher education*, *14*(1), pp.1-28.

Abbott-Chapman, J., Martin, K., Ollington, N., Venn, A., Dwyer, T. and Gall, S., 2014. The longitudinal association of childhood school engagement with adult educational and occupational achievement: Findings from an Australian national study. *British Educational Research Journal*, *40*(1), pp.102-120.

Mceleli, B.M. 2019. *Enhancing mathematics pedagogical content knowledge in Grade 9 class using problem-based learning* (Doctoral dissertation). University of the Free State.

Menon, S. and Suresh, M., 2022. Modelling the enablers of sustainability in higher education institutions. *Journal of Modelling in Management*, *17*(2), pp.405-439.

Merchant, B. and Garza, E., 2015. The urban school leader's collaborative: Twelve years of promoting leadership for social justice. *Journal of Research on Leadership Education*, *10*(1), .39-62.

Mertens, D.M. 2021. Transformative research methods to increase social impact for vulnerable groups and cultural minorities. *International Journal of Qualitative Methods*, 20, p.16094069211051563.

Mgijima, V.D. 2021. Advancing text prediction skills through translanguaging. *Reading & Writing*, 12(1), pp.1-10.

Koehler, M.J., Shin, T.S. and Mishra, P., 2012. How do we measure TPACK? Let me count the ways. In *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 16-31). IGI Global.

Mishra, P. and Koehler, M.J. 2006. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), pp.1017-1054.

Boon, Q.W., 2021. A Review of The Management Theory For Special Education Task Load Perspective. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(11), pp.5234-5238.

Morales, J., Jimenez, L., Sargrad, S., and Thompson, M., 2016. Remedial Education: The Cost of Catching Up. *Center for American Progress*.

Moreno, M.M., Bartolic, S.K., Boud, D., Agapito, J., Verpoorten, D., Williams, S., Lutze-Mann, L., Matzat, U., Moreno, M.M., Polly, P., Tai, J. and Marsh, H.L., 2022. A multi-institutional assessment of changes in higher education teaching and learning in the face of COVID-19. *Educational Review*, *74*(3), pp.517-533.

Mosia, M.S. 2016. *Improving teachers' technological pedagogical content knowledge for teaching Euclidean geometry using integrated information communication technologies software* (Doctoral dissertation). University of the Free State.

Mpu, Y., Roy, I. and Hackmack, K. 2022. Teacher Educator Reflections on Preparing First Year Pre-Service Teachers for School-Based Work Integrated Learning in an Online Learning Environment. *Research in Social Sciences and Technology*, *7*(3), pp.18-35.

Murris, M., Polverino, E., Goeminne, P.C., McDonnell, M.J., Aliberti, S., Marshall, S.E., Loebinger, M.R., Cantón, R., Torres, A., Dimakou, K. and De Soyza, A., 2017. European Respiratory Society guidelines for the management of adult bronchiectasis. *European Respiratory Journal*, *50*(3).

Murris, K. and Reynolds, R.A., 2018. Reggio Emilia inspired philosophical teacher education in the Anthropocene: Posthuman child and the family (tree).

Nasution, A.B.M.D., Sidiq, E.I., Faujan, M.L.Y. and Tabroni, I., 2023. Increasing understanding of fiqh: Problem based learning (pbl) drives it all. *International Journal of Integrative Sciences*, *2*(2), pp.65-78.

Nath, S.R., 2022. Capability of preschool education in enhancing primary school competencies in Bangladesh. *Journal of Research in Childhood Education*, *36*(1), pp.14-30.

National Council of Teachers of Mathematics. 1991. Professional standards for teaching mathematics. Reston: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA:

National Planning Commission, 2013. National development plan vision 2030.

Nelson, D. 2017. *Participatory Action Research: A Literature Review.* Available from https://www.researchgate.net./publication/321398218 [accessed 7 Oct 2021].

Neuman, M.J. and Okeng'o, L., 2019. Early childhood policies in low-and middle-income countries. *Early Years*, *39*(3), pp.223-228.

Ngubane, N., Ntombela, B.X. and Govender, S. 2020. Translanguaging pedagogy in selected English First Additional Language writing classrooms. *Southern African Linguistics and Applied Language Studies*, 38(2), pp.142-151.

Nhlapo, V. 2021. Enhancing the Management Performance of Departmental Heads in Primary and Secondary Schools: PAR as a Practice-Enhancing Process. *Educational Research for Social Change*, 10(1), pp.83-101.

Niederhauser, D.S., Howard, S.K., Voogt, J., Agyei, D.D., Laferriere, T., Tondeur, J. and Cox, M.J., 2018. Sustainability and scalability in educational technology initiatives: Research-informed practice. *Technology, Knowledge, and Learning*, *23*, pp.507-523.

Nikolopoulou, K. and Gialamas, V. 2015. ICT and play in preschool: early childhood teachers' beliefs and confidence. *International Journal of Early Years Education*, 23(4), pp.409-425.

Niv, Y., Daniel, R., Geana, A., Gershman, S.J., Leong, Y.C., Radulescu, A. and Wilson, R.C., 2015. Reinforcement learning in multidimensional environments relies on attention mechanisms. *Journal of Neuroscience*, *35*(21), pp.8145-8157.

Ochieng, V.O. and Waithanji Ngware, M., 2023. Adoption of education technologies for learning during COVID-19 pandemic: The experiences of marginalized and

vulnerable learner populations in Kenya. *International journal of educational reform*, *32*(4), pp.464-487.

Omolo, H. and Otara, A., 2021. School organizational factors as predictors of student achievement: Principals' perspective.

Onyema, E.M. 2020. Integration of emerging technologies in teaching and learning process in Nigeria: the challenges. *Central Asian Journal of Mathematical Theory and Computer Sciences*, 1(1), pp.35-39.

Osumba, J., Shilomboleni, H., Recha, J., Radeny, M. and 2023. Scaling climate resilient seed systems through SMEs in Eastern and Southern Africa: challenges and opportunities. *Climate and Development*, *15*(3), pp.177-187.

Paiva, A., Chandra, and S., Dillenbourg, P. 2017, June. Classification of children's handwriting errors for the design of an educational co-writer robotic peer. In *Proceedings of the 2017 Conference on Interaction Design and Children* (pp. 215-225).

Palsa, L. and Mertala, P. 2022. Disciplinary contextualisation of transversal competence in Finnish local curricula: the case of multiliteracy, mathematics, and social studies. *Education Inquiry*, 13(2), pp.226-247.

Peterson, L. and Scharber, C., 2018. Learning about makerspaces: Professional development with K-12 inservice educators. *Journal of Digital Learning in Teacher Education*, *34*(1), pp.43-52.

Pholotho, T. and Mtsweni, J. 2016. *Barriers to electronic access and delivery of educational information in resource constrained public schools: A case of Greater Tubatse Municipality.* In 2016 IST-Africa Week Conference (pp. 1-9). IEEE.

Piper, B., Jepkemei, E., Kwayumba, D. and Kibukho, K., 2015. Kenya's ICT Policy in Practice: The Effectiveness of Tablets and E-Readers in Improving Student Outcomes. *FIRE: Forum for International Research in Education,* 2(1), pp. 3-18.

Pope, L., Harvey-Berino, J., Gold, B.C., Leonard, H. and Belliveau, C., 2012. Undergrad and overweight: an online behavioral weight management program for college students. *Journal of nutrition education and behavior*, *44*(6), pp.604-608.

Powell, L. and McGrath, S., 2014. 7 Exploring the Value of the Capability Approach for Vocational Education and Training Evaluation: Reflections from South Africa. In *Education, Learning, Training* (pp. 126-148). Brill Nijhoff.

Qhosola, M.R. 2016. *Creating sustainable learning environments for a Grade 10 accounting classroom: A critical accounting approach* (Doctoral dissertation). University of the Free State.

Qhosola, M.R. and Mahlomaholo, S. 2022. Creating sustainable Posthuman Adaptive Learning environments for pregnant teenagers. *Agenda*, 36(1), pp.54-64.

Raynor, R. 2019. Speaking, feeling, mattering: Theatre as method and model for practice-based, collaborative, research. *Progress in Human Geography*, 43(4), pp.691-710.

Republic of Kenya. 2017. *Education and Training Sector Draft Medium Term Plan III for the Period 2018–2022.* Nairobi: Government Printer.

Republic of South Africa. (RSA). 2015. National Integrated Early Childhood Development Policy. Pretoria: Government Printers.

Republic of South Africa (RSA). 2021. Protection of Personal Information Act (or POPI Act)

Rich, K.M., Binkowski, T.A., Strickland, C. and Franklin, D., 2018, August. Decomposition: A K-8 computational thinking learning trajectory. In *Proceedings of the 2018 ACM conference on international computing education research* (pp. 124-132).

Rogers, R., 2004. An introduction to critical discourse analysis in education. In *An introduction to critical discourse analysis in education* (pp. 31-48). Routledge.

Rossetti, S., Zappia, D., Sanzari, M., Schaerf, M. and Pirri, F., 2022, October. Max pooling with vision transformers reconciles class and shape in weakly supervised semantic segmentation. In *European Conference on Computer Vision* (pp. 446-463). Cham: Springer Nature Switzerland.

Sakaria, D.A., Maat, S.M.B. and Matore, M.E.E. 2023. Factors Influencing Mathematics Teachers' Pedagogical Content Knowledge (PCK): A Systematic Review. *Pegem Journal of Education and Instruction*, 13(2), pp.1-14.

Santos, J.M. and 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), p.100110.

Schiffrin, Tannen, & Hamilton. 2001. The handbook of discourse analysis. Oxford: Blackwell.

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P., Koehler, M.J. and Shin, T.S. 2009. Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of research on Technology in Education*, 42(2), pp.123-149.

Schotte, K., Rjosk, C., Edele, A., Hachfeld, A. and Stanat, P., 2022. Do teachers' cultural beliefs matter for students' school adaptation? A multilevel analysis of students' academic achievement and psychological school adjustment. *Social Psychology of Education*, *25*(1), pp.75-112.

Shah, Y.I. Hu, Z., and Yao, P., 2021. Experimental and numerical study on interface bond strength and anchorage performance of steel bars within prefabricated concrete. *Materials*, *14*(13), p.3713.

El-Sharkawy, S., Yamagishi-Eichler, N. and Schmid, K., 2019. Metrics for analyzing variability and its implementation in software product lines: A systematic literature review. *Information and Software Technology*, *106*, pp.1-30.

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

Shulman, L.S. 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), pp.4-14.

Sibisi, P.N. 2019. Lecturers' experiences in the implementation of the National Certificate (Vocational) Engineering curriculum in a selected Technical Vocational Education and Training college. *SIGNATURE*, 2019, pp.11-29.

Siyepu, S.W., Adendorff, S.A., and Mntunjani, L.M. 2018. Foundation phase teachers' use of manipulatives to teach number concepts: A critical analysis. *South African Journal of Childhood Education*, *8*(1), pp.1-9.

Siyepu, S.W. and Vimbelo, S.W. 2021. Pre-service teachers' mathematical engagement in learning about the total surface areas of geometrical solids. *South African Journal of Education*, 41(2), pp.1-13.

Somuncu, B. and Aslan, D. 2022. Effect of coding activities on preschool children's mathematical reasoning skills. *Education and Information Technologies*, 27(1), pp.877-890.

Teele, S.A., Sindelar, A., Brown, D., Kane, D.A., Thatte, N., Williams, R.J., Gueverra, J. and Wolbrink, T.A., 2021. Online education in a hurry: delivering pediatric graduate medical education during COVID-19. *Progress in pediatric cardiology*, *60*, p.101320.

Teele, T., Nkoane, M. and Mahlomaholo, S. 2020. Erudite pedagogic praxis of extension paradigm for technological skills transfers of the emerging farmers. *South African Journal of Agricultural Extension*, 48(2), pp.106-112.

Tenorio, E.H. 2011. Critical discourse analysis, an overview. *Nordic Journal of English Studies*, 10(1), pp.183-210.

Umugiraneza, O., Bansilal, S. and North, D. 2017. Exploring teachers' practices in teaching mathematics and statistics in KwaZulu-Natal schools. *South African Journal of Education*, 37(2).

Tsotetsi, C.T. and Mahlomaholo, S., 2015. Exploring strategies to strengthen continuing professional development of teachers in rural South Africa. *Journal of Higher Education in Africa/Revue de l'enseignement supèrieur en Afrique*, *13*(1-2), pp.45-73.

United Nations Educational, Scientific and Cultural Organization (UNESCO), 2020. Global education monitoring report 2020: Inclusion and education: All means all. *92310038*.

Majumdar, S.H.Y.A.M.A.L., 2014. UNESCO-UNEVOC catalyses networking and partnership in TVET in the post-2015 agenda. *BWP*, *6*, pp.16-17.

Valera, L. 2014. Posthumanism: beyond humanism? *Cuadernos de Bioética*, 25(3), pp.481-491.

Van der Sandt, S. 2007. Research framework on mathematics teacher behaviour: Koehler and Grouws' framework revisited. *Eurasia Journal of Mathematics, Science and Technology Education,* 3(4), pp.343-350.

Van Dijk, T.A. 1995. Aims of critical discourse analysis. *Japanese Discourse*, 1(1), pp.17-28.

Van Dijk, T.A. 2001. Multidisciplinary CDA: A plea for diversity. In R. Wodak & M. Meyer (Eds.), *Methods of critical discourse analysis* (pp.95-120). London: Sage.

Van Dijk, T.A. 2008. Discourse and context. *A sociocognitive approach.* London: Cambridge.

Van Leeuwen, T. 2008. *Discourse and practice: New tools for critical discourse analysis*. New York: Oxford University Press.

Voogt, J. and McKenney, S. 2017. TPACK in teacher education: Are we preparing teachers to use technology for early literacy. *Technology, Pedagogy and Education*, 26(1), pp.69-83.

Walters, P.B., Lareau, A. and Ranis, S. eds., 2009. *Education research on trial: Policy reform and the call for scientific rigor*. Routledge.

Wamunga, F.M. and Wakhu, D.O. 2021. Enhancing Health-Seeking Behavior: A Case of Khwisero Sub-County, Kakamega County, Kenya. *Africa Environmental Review Journal*, 4(2), pp. Pg148-158.

Webb, M. and Cox, M. 2004. A review of pedagogy related to information and communications technology. *Technology, Pedagogy and Education*, 13(3), pp.235-286.

Woldemichael, M., Eshetu, and D., Atnafu, M. 2022. The Effectiveness of Guided Inquiry-Based Technology Integration on Pre-Service Mathematics Teachers' Understanding of Plane Geometry. *Journal of Pedagogical Research*, *6*(4), pp.84-100.

Yan, S., Whittle, C., Tiwari, S., and Williams, J., 2020. Emergency remote teaching environment: A conceptual framework for responsive online teaching in crises. *Information and Learning Sciences*, *121*(5/6), pp.311-319.

Yüksel, B., 2022. *EARLY CHILDHOOD EDUCATION TEACHERS'TEACHING EXPERIENCES ON MOTOR DEVELOPMENT OF CHILDREN DURING THE COVID-19 PANDEMIC* (Master's thesis, Middle East Technical University).

Zainul, R., Adri, M., Wahyuningtyas, N., Wedi, A., Surahman, E., Aisyah, E.N., Oktaviani, H.I., Meilanie, R.S.M., Purnamawati, S.N., Listyasari, W.D. and Santoso,

Y., 2020, July. Development of e-learning courses for subjects about ‘learn and learning’with moodle-based for prospective teacher in indonesia. In *Journal of Physics: Conference Series* (Vol. 1594, No. 1, p. 012023). IOP Publishing.

## APPENDICES

## APPENDIX A: LETTER FROM LANGUAGE EDITOR

Carmen
Nel
BA INFSCIENCE

EDITING SERVICES
072 377 5585
carmen@ufs.ac.za

### CERTIFICATE OF LANGUAGE EDITING

This certifies that I have edited the work detailed below below for language.

**Title:**

"ENHANCING THE USE OF TABLETS IN TEACHING GRADE R MATHEMATICS

AMONG ECD PRE-SERVICE TEACHERS AT A TVET COLLEGE IN GAUTENG"

**by**

DUDUZILE PRETTY SIBANYONI

Student number: 220143625

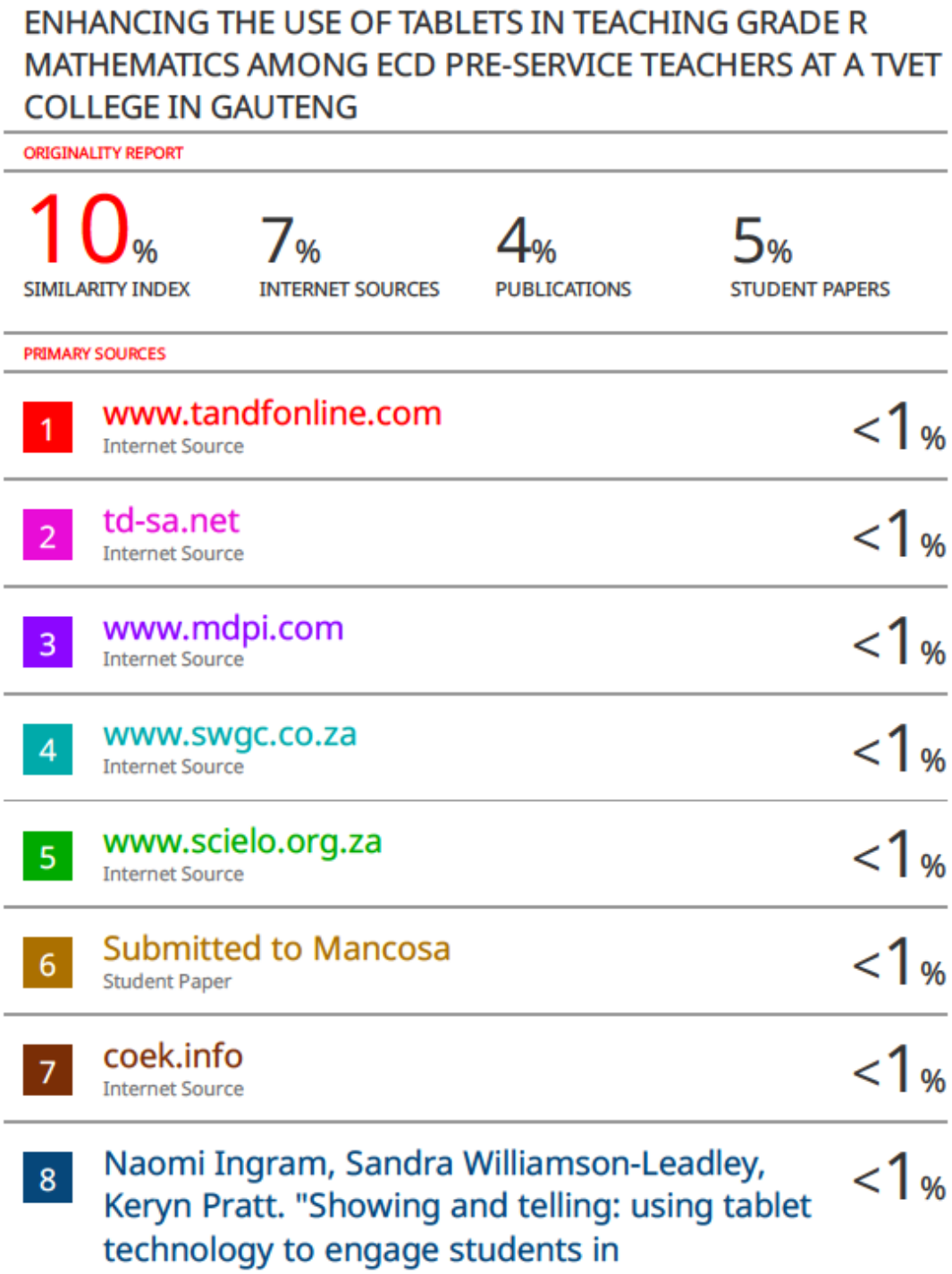
Regards

Carmen Nel 21

January 2024

Professional editing of articles, thesis, dissertations and books

## APPENDIX B: PLAGIARISM REPORT



ENHANCING THE USE OF TABLETS IN TEACHING GRADE R MATHEMATICS AMONG ECD PRE-SERVICE TEACHERS AT A TVET COLLEGE IN GAUTENG

ORIGINALITY REPORT

| 10% | 7% | 4% | 5% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | www.tandfonline.com<br>Internet Source | <1% |
| 2 | td-sa.net<br>Internet Source | <1% |
| 3 | www.mdpi.com<br>Internet Source | <1% |
| 4 | www.swgc.co.za<br>Internet Source | <1% |
| 5 | www.scielo.org.za<br>Internet Source | <1% |
| 6 | Submitted to Mancosa<br>Student Paper | <1% |
| 7 | coek.info<br>Internet Source | <1% |
| 8 | Naomi Ingram, Sandra Williamson-Leadley, Keryn Pratt. "Showing and telling: using tablet technology to engage students in | <1% |

| | | |
|---|---|---|
| | Student Paper | |
| 16 | files.osf.io<br>Internet Source | <1% |
| 17 | www.edusacollege.co.za<br>Internet Source | <1% |
| 18 | vital.seals.ac.za:8080<br>Internet Source | <1% |
| 19 | Mustafa Ahmed Abdullah. "Using the educational tablet: An evaluation study of teachers' and pupils' views in Egyptian primary schools", Education and Information Technologies, 2022<br>Publication | <1% |
| 20 | www.bth.se<br>Internet Source | <1% |
| 21 | Submitted to Walter Sisulu University<br>Student Paper | <1% |
| 22 | joe.ukzn.ac.za<br>Internet Source | <1% |
| 23 | Submitted to Flinders University<br>Student Paper | <1% |
| 24 | Submitted to University of Pretoria<br>Student Paper | <1% |
| 25 | innovationeducation.biomedcentral.com<br>Internet Source | <1% |

| | | |
|---|---|---|
| 53 | Lida Jarahi, Alireza Ebrahimi, Mostafa Rashki, Alireza Ghodsi. "Assessing the Implementation Requirements of the Flipped Classroom Model for Medical Students: A Multi-Domain Evaluation", Research Square Platform LLC, 2023<br>Publication | <1% |
| 54 | www.up.ac.za<br>Internet Source | <1% |
| 55 | Submitted to University of Glasgow<br>Student Paper | <1% |
| 56 | Zongyi Deng *. "Beyond teacher training: Singaporean teacher preparation in the era of new educational initiatives", Teaching Education, 2004<br>Publication | <1% |
| 57 | Sands, Heather C.. "A Thin Line of Social Justice: Challenges and Changes in Navigating Relations of Power in Graduate Schools of Education", The University of New Mexico, 2023<br>Publication | <1% |
| 58 | Submitted to University of Western Ontario<br>Student Paper | <1% |
| 59 | www.cambridgenigeriapub.com<br>Internet Source | <1% |

| | | |
|---|---|---|
| 45 | Submitted to University of Cape Town<br>Student Paper | <1% |
| 46 | eprints.usq.edu.au<br>Internet Source | <1% |
| 47 | Ronel Blom, James Keevy, Withfield Green, Michelle Mathey, Gerda Magnus, Sello Sethusha. "Chapter 18 Positioning TVET Lecturer Identities at the Centre of TVET Lecturer Education and Training in a Post-COVID-19 Context", Springer Science and Business Media LLC, 2022<br>Publication | <1% |
| 48 | etd.ohiolink.edu<br>Internet Source | <1% |
| 49 | minds.wisconsin.edu<br>Internet Source | <1% |
| 50 | Submitted to National University of Singapore<br>Student Paper | <1% |
| 51 | Submitted to Foundation for Professional Development<br>Student Paper | <1% |
| 52 | Johannsdottir, B. "The mathematical content knowledge of prospective teachers in Iceland", Proquest, 2014.<br>Publication | <1% |

| | | |
|---|---|---|
| 60 | Submitted to North West University<br>Student Paper | <1% |
| 61 | Submitted to University of South Africa<br>Student Paper | <1% |
| 62 | eresearch.qmu.ac.uk<br>Internet Source | <1% |
| 63 | pdf.usaid.gov<br>Internet Source | <1% |
| 64 | www.researchgate.net<br>Internet Source | <1% |
| 65 | www.ruw.edu.bh<br>Internet Source | <1% |
| 66 | Greene, Ursula Sample. "An Examination of Professional Development's Role on Stakeholder's Self-Efficacy to Implement an Effective Exceptional Education Program", Trevecca Nazarene University, 2023<br>Publication | <1% |
| 67 | De'Johnette, Sharrieff Rahseem. "A Qualitative Case Study of Virginia State University Preservice Teachers' Perceptions of Information Communication Technology and Social Media", Northcentral University, 2021<br>Publication | <1% |
| 68 | Noblitt, Bethany Anne. "The effects of instruction on the algebra self-efficacies of | <1% |

| | | |
|---|---|---|
| | prospective middle grades teachers", Proquest, 20111109<br>Publication | |
| 69 | scholar.sun.ac.za<br>Internet Source | <1% |
| 70 | Submitted to University of East London<br>Student Paper | <1% |
| 71 | s9153cb9bea9cc6f2.jimcontent.com<br>Internet Source | <1% |
| 72 | www.ejmste.com<br>Internet Source | <1% |
| 73 | Oyedele, Ola Olusegun. "Workforce Diversity Management and Performance in Food and Beverage Industry in Lagos State, Nigeria.", Kwara State University (Nigeria), 2019<br>Publication | <1% |
| 74 | oapub.org<br>Internet Source | <1% |
| 75 | www.lovedalecollege.co.za<br>Internet Source | <1% |
| 76 | Cetin-Berber, Duygu, and Ali Erdem. "An Investigation of Turkish Pre-Service Teachers' Technological, Pedagogical and Content Knowledge", Computers, 2015.<br>Publication | <1% |
| | Submitted to Charles Darwin University | |

| | | |
|---|---|---|
| 86 | www.eliterarysociety.com<br>Internet Source | <1% |
| 87 | Submitted to University of Edinburgh<br>Student Paper | <1% |
| 88 | Submitted to University of Witwatersrand<br>Student Paper | <1% |
| 89 | carbochange.eu<br>Internet Source | <1% |
| 90 | jlahnet.com<br>Internet Source | <1% |
| 91 | mostwiedzy.pl<br>Internet Source | <1% |
| 92 | researchspace.ukzn.ac.za<br>Internet Source | <1% |
| 93 | Submitted to Universiti Sains Malaysia<br>Student Paper | <1% |
| 94 | ebin.pub<br>Internet Source | <1% |
| 95 | news360gh.com<br>Internet Source | <1% |
| 96 | pure.qub.ac.uk<br>Internet Source | <1% |
| 97 | Ben Zunica. "Technology everywhere! But who's got the time? The influence of time | <1% |

| | | |
|---|---|---|
| | Employed Nurses' Adaptation in Malaysia", Research Square Platform LLC, 2023<br>Publication | |
| 102 | Submitted to Kenyatta University<br>Student Paper | <1% |
| 103 | Motseki, Puleng Dorah. "Acquisition of Geometric Thought: A Case Study of Technical Vocational Education and Training College Learners", University of Johannesburg (South Africa), 2021<br>Publication | <1% |
| 104 | Presswood, Amanda. "Contending With Language Difference in the Writing Center: An Investigation of Attitudes and Expectations Toward Second Language Writers", The Florida State University, 2023<br>Publication | <1% |
| 105 | Submitted to University of Alabama<br>Student Paper | <1% |
| 106 | aa-rf.org<br>Internet Source | <1% |
| 107 | digitalcommons.latech.edu<br>Internet Source | <1% |
| 108 | ejrsme.icrsme.com<br>Internet Source | <1% |
| 109 | napier-repository.worktribe.com<br>Internet Source | |

| | | |
|---|---|---|
| | | <1% |
| 110 | uir.unisa.ac.za<br>Internet Source | <1% |
| 111 | ursa.mercer.edu<br>Internet Source | <1% |
| 112 | "Book Review", Innovations in Education and Teaching International, 2002<br>Publication | <1% |
| 113 | Fung, Kristen E.. "Minecraft in Language Teacher Education: Acceptance and Integration in Practice", University of South Florida, 2022<br>Publication | <1% |
| 114 | Michelle M. Neumann, Guy Merchant, Cathy Burnett. "Young children and tablets: the views of parents and teachers", Early Child Development and Care, 2018<br>Publication | <1% |
| 115 | Susan Catapano. "Teaching in urban schools: mentoring pre-service teachers to apply advocacy strategies", Mentoring & Tutoring: Partnership in Learning, 2006<br>Publication | <1% |
| 116 | T Teele, M Nkoane, S. Mahlomaholo. "Erudite pedagogic praxis of extension paradigm for technological skills transfer of the emerging | <1% |

farmers", South African Journal of Agricultural Extension (SAJAE), 2020
Publication

| | | |
|---|---|---|
| 117 | H. Richard Milner. "Reflection, Racial Competence, and Critical Pedagogy: How do we prepare pre-service teachers to pose tough questions?", Race Ethnicity and Education, 2003<br>Publication | <1% |
| 118 | Mona S. Alghamdi. "The Reality and Difficulties of Employing ICT in Teaching from the Perspective of Math Teachers of Middle Stage in Riyadh", International Education Studies, 2017<br>Publication | <1% |
| 119 | journals.ukzn.ac.za<br>Internet Source | <1% |

| | | | |
|---|---|---|---|
| Exclude quotes | On | Exclude matches | < 5 words |
| Exclude bibliography | On | | |

## APPENDIX C: ETHICAL CLEARANCE CERTIFICATE: UNIVERSITY OF MPUMALANGA

UNIVERSITY OF MPUMALANGA

Creating Opportunities

Prof Mahlomaholo Geoffrey MAHLOMAHOLO

School of Early Childhood Education (SECE)

Siyabuswa Campus.

Dear Sibanyoni DP

220143625

**Protocol Reference Number:** UMP/Sibanyoni220608768/SECE /MEd/2023

**Project Title:** Enhancing the use of tablets in teaching grade-R mathematics among ECD pre-service teachers at a TVET college in Gauteng.**Approval Notification**

**FULL APPROVAL.**

**Any alteration/s to the approved research protocol i.e. Questionnaire/Interviews Schedule, Informed Consent form, Title of the project, Location of the study, Research Approach and methods must be reviewed and approved through the amendment/ modification prior to its implementation. In case you have further queries, please quote the above reference number.**

**PLEASE NOTE: Research data should be stored securely in the School/ division for a period of 5 years.**

**The Ethical Clearance certificate is only valid for a period of 3 years from date of issue. Thereafter, Recertification must be applied for on an annual basis.**

Wishing you the best with your study.

Yours faithfully,

Prof MG Mahlomaholo

Name of Chairperson **(Chair FREC)**

Cc: Research Office Administrator: Mr N Kashe and Ms T Mlambo

Cc: Faculty Research Committee Chair: Prof H Israel

**DECLARATION OF INVESTGATOR(S)**

I/We fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and guarantee to ensure compliance with these conditions. I agree to completion of a yearly progress report.

..... .....

Signature Date

## APPENDIX D: ETHICAL CLEARANCE CERTIFICATE: DEPARTMENT OF HIGHER EDUCATION AND TRAINING

Higher education &

training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

Enquiries: Mr M Radise Tel: 0825894821 Email: radise.mm@dhet.gov.za

TO: Ms. DP Sibanyoni

FROM. Mr MM Radise

DATE: 11 August 2023

SUBJECT: GRANTING OF AN APPROVAL TO CONDUCT RESEARCH TOWARDS YOUR MASTER'S DEGREE

Dear Ms. Sibanyoni

The Department of Higher Education and Training has acknowledged receipt of your request to conduct a Research towards the fulfilment of your studies with the University of Mpumalanga.

The department wishes you all the in your journey to improve your knowledge and skills; however, it is more appreciated when the college and the community will benefit from your study.

The Department of Higher Education and Training, hereby grant permission to conduct the requested research towards the completion of your study.

Regards

11/08/23.

## APPENDIX E: REQUEST LETTER TO THE ACADEMIC MANAGER

**REQUEST TO CONDUCT RESEARCH**

Duduzile Sibanyoni

0782311269

Prof. Mahlomaholo

0647513356

Date: October 2022

The principal

Western TVET College

Randfontein Campus

**Request for permission to conduct research at your college.**

Dear Principal

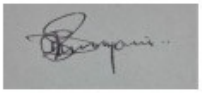
I, **Duduzile Pretty Sibanyoni**, a master's degree candidate at the university of Mpumalanga doing research under the supervision of **Professor Mahlomaholo**, humbly request your permission to conduct research at your institution. My student number is **220143625.**

I am requesting to conduct research at your college and inviting you to participate in the study entitled: ***Enhancing the use of tablets in teaching Grade R mathematics among ECD pre-service teachers at a TVET college in Gauteng. Your school was selected because it is ideal for gathering information about the benefits of using tablets in teaching the mathematics curriculum in Grade R***. This study formulates a strategy to enhance the effective use of tablets in teaching Grade-R mathematics among Education and Childhood Development (ECD) pre-service teachers at a TVET college.

The study will entail working together with preservice teachers during their teaching practice and beyond, lecturers, teachers, principal, and parents, ESs and leaners. This study is not supposed to be risky, and therefore, no risky situations are expected. Participation in the study is entirely voluntary and every participant has the right to withdraw without any repercussions from participating in the study at any time if a situation arises and make you feel comfortable. There will be no reimbursement or any incentives for participation in the research. Feedback will be given in writing and word of mouth.

Thanking you in advance

Yours sincerely



Ms. DP Sibanyoni

## APPENDIX F: PERMISSION LETTER FROM THE TVET COLLEGE

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

*Enquiries: Mr S Mogotsi* *Tel: 011 953 1140* *Email: smogosti@westcol.co.za*

**TO: Ms. DP Sibanyoni**

**FROM. Mr S Mogotsi**

**DATE: 02 September 2023**

**SUBJECT: APPROVAL TO CONDUCT RESEARCH TOWARDS YOUR MASTER'S DEGREE**

Dear Ms. DP Sibanyoni

The college wish to congratulate you on your studies with the University of Mpumalanga.

We have received your request and I hereby grant you permission to conduct the study and believe that it will not only benefit you but the college and the TVET sector at large.

Regards

02/09/2023