Cape Peninsula
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INTERACTIVE WHITEBOARD TO ENHANCE LEARNING ENGAGEMENT IN LARGE CLASSES IN WESTERN CAPE PRIMARY SCHOOLS

by

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DECLARATION

I, Inga Sharter, declare that the contents of this dissertation/thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

2024/10/17

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ABSTRACT

As a primary school educator, the researcher encountered constraints in the classroom, including learners who refused to engage and participate during lessons. This reluctance to engage pedagogically in classroom activities negatively impacted teacher-learner relationships. Consequently, the primary aim of this study was to enhance learner participation in large classes using interactive digital tools, specifically the Interactive Whiteboard (IWB).

This qualitative research study was grounded in interpretivist educational theory. The researcher employed two data collection methods: classroom observations and focus group interviews. The study involved six participants and was conducted over three action research cycles. The framework that guided the research was the Technological Pedagogical and Content Knowledge (TPACK) framework, enabling the identification of themes and the analysis of collected data.

In summary, the findings indicate that using the IWB significantly improved learner participation. The learners' responses highlighted the various components of the TPACK framework, illustrating how the IWB functioned not only as a technological tool but also as an integral part of a holistic educational strategy that effectively combined technological, pedagogical, and content knowledge.

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DEDICATION

I dedicate this thesis to my grandmother, Katy Sharter,
and my mother, Elize Peterson.

Thank you for instilling in me the belief that the sky is never the limit and that anything is achievable through hard work, dedication, and faith. Despite not having the opportunity to complete high school yourselves, you have been my greatest inspiration, motivating me to reach heights I never thought possible.

This degree is for us.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

3D	Three-Dimensional
CAD	Computer-Aided Design
CK	Content Knowledge
CPUT	Cape Peninsula University of Technology
DBE	Department of Basic Education
DMP	Data Management Plan
DOE	Department of Education
ENIAC	Electronic Numerical Integrator and Computer
FGD	Focus Group Discussion
ICT	Information and Communication Technology
IWB	Interactive Whiteboard
PCK	Pedagogical Content Knowledge
PK	Pedagogical Knowledge
TK	Technological Knowledge
TPACK	Technological, Pedagogical, and Content Knowledge
WCED	Western Cape Education Department

APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Background and motivation

Research into classroom practices has become a highly investigated phenomenon in South African schools. The researcher has been teaching for eight years at a primary school in Paarl, in the Western Cape province of South Africa. Each year, the learner-teacher ratio of 1:37 is often exceeded in the classroom. According to West and Meier (2020:1), the South African education system faces a shortage of qualified teachers and overcrowded classrooms. Having more learners than the recommended teacher-learner ratio has led to many obstacles. According to Muthusamy (2015), teachers encounter various challenges when teaching in overcrowded classrooms, which lead to numerous negative implications for both teachers and learners. Muthusamy (2015:1) elaborates that some of these negative implications include frustrated teachers and learners, a lack of participation, and overall discouragement.

The researcher has encountered constraints in the classroom, such as learners who refuse to participate and engage during lessons. This reluctance on the part of learners to engage pedagogically in classroom practices adversely affects teacher-learner relations. Bolliger and Martin (2018) explain that learner engagement is the learner's psychological investment in efforts directed towards learning, understanding, and mastering knowledge. Furthermore, they state that learner engagement is developed through interaction (Bolliger & Martin, 2018). Bundick, Quaglia, Corso and Haywood (2014) espouse a similar idea that the more learners are engaged, the more likely they are to perform academically. It is argued that the ideal pedagogical process should involve learners more, encouraging their participation and contribution throughout lessons (Zeegers & Elliot, 2018:17). Zeegers and Elliot (2018) further note that disengagement is characterised by learners' shyness, visible discomfort, and limited participation in pedagogical activities. Ideally, a 'good classroom' should foster two-way interaction between learners and the teacher (Bolliger & Martin, 2018).

In 2018, at the researcher’s school, eight classrooms were equipped with interactive whiteboards (IWBs), laptops, and E-beams. Bolliger and Martin (2018) emphasise that as class sizes grow, understanding how educational technology enhances learner engagement becomes increasingly important. Ersan (2018) supports this view, indicating that studies have shown technology, such as IWBs, can improve learner engagement. Önal (2017:68) echoes this perspective, arguing that IWBs can significantly contribute to engagement in the classroom. Research has shown that more teachers are utilising Information and Communication Technology (ICT) in the classroom, particularly the IWB.

Lamberth (2012) asserts that IWBs play a crucial role in fostering learner engagement. Ersan (2018:201) highlights several advantages of IWB use, noting that teachers can quickly and conveniently present visual material to learners. This technology also enhances learners' contributions, as they actively engage in lessons. Maryam, Sören, and Gunilla (2018:80) support Ersan's (2018) view, emphasising that teachers using IWBs encourage learner discussions. Kirbas (2018:1040) concurs, suggesting that IWBs allow learners to participate more effectively. Additionally, IWBs positively influence learners' personal and social development, promoting collaboration and participation in lessons. However, despite extensive literature advocating for IWBs to address learner disengagement in large classes within Western Cape primary schools, challenges with maintaining consistent engagement in pedagogical interactions persist.

The Western Cape education system in South Africa has experienced substantial transformation in the post-apartheid era. Challenges such as limited resources remain in large classrooms (West & Meier, 2020). Due to a shortage of teachers, the quality of teaching has had a negative effect on learner engagement (Motala & Carel, 2019). The policies have been revised by the Department of Basic Education (DBE) to improve the teacher–learner ratios. This has been challenging, leaving many schools with ratios that exceed the recommended teacher-learner ratios (South African DBE, 2023). Furthermore, van der Berg et al. (2016) mention that disparities in teacher distribution exacerbate challenges for schools, making it difficult to maintain effective teaching practices. The IWBs have been used in many South-African schools with the expectation of enhancing learner engagement and providing teachers with new tools to facilitate interactive learning, particularly in large classrooms (Önal, 2017). This expectation is supported by numerous studies that have shown IWBs can serve as effective tools for promoting participation; however, their success is highly dependent on the context in which they are used (Ersan, 2018). For instance, Önal (2017) states that IWBs can transform classroom interaction, making it easier for learners to engage with the presented content. However, as Blignaut, Hinostroza, Els, and Brun (2010) note, integrating such technology often encounters obstacles due to inadequate training and varying levels of ICT readiness among teachers.

Even though there are many pros in digital technology, research focusing on the impact of IWBs in large classrooms within South African primary schools remains limited, particularly in contexts such as the schools of the Cape Winelands. This study seeks to explore how IWBs can address learner disengagement in this specific context, building on previous findings while offering new insights into the potential of educational technology to transform classroom dynamics (Chigona & Chigona, 2010). This research aims to expand on the claim that educational technologies can enhance learner participation in pedagogical activities. By

critically examining the use of IWBs, it seeks to contribute to a deeper understanding of how technology can support teaching in environments where large class sizes challenge traditional methods.

1.2 Statement of the problem

This study examines the significant challenges created by a high learner-to-teacher ratio for both teachers and learners. At the primary school level, this ratio has risen from 1:40 in 2016 to 1:45 in recent years, exceeding the DBE's recommended maximum of 1:37, which defines a "large classroom" (South African DBE, 2023). Such an imbalance places substantial strain on teachers, who face difficulties in delivering effective instruction within overcrowded environments. This situation leads to increased frustration and stress among teachers and limits their capacity to provide individualised attention to learners.

The above-mentioned circumstances have led to issues of learner engagement, based on early observations showing that many learners are withdrawn, hesitant to participate in discussions, and often reluctant to ask for help. This disengagement poses a serious concern, as learner participation and active engagement are critical for academic success and mastery of content (Bolliger & Martin, 2018). Tertrmiz, Kalyon, Can, Duzgun and Serkon (2015) mention that without addressing this disengagement, learners risk becoming passive recipients of information, which limits their development of critical thinking skills and overall achievement.

While teachers have no control over learner-to-teacher ratios, digital technology, such as IWBs, offers potential strategies for fostering engagement in large classrooms. In South–African schools, IWBs have been introduced to enhance learner interaction and engagement. However, due to challenges such as poor teacher training and difficulties in adapting to ICT in the classroom, the effectiveness of the IWB is often limited (Ersan, 2018; Önal, 2017). As a result, many teachers find it challenging to align the use of IWBs with their pedagogical practices, reducing the impact of this technology in mitigating disengagement (Blignaut et al., 2010).

This study explores how IWBs can be utilised more effectively to address learner disengagement in large classrooms at a primary school in the Paarl Winelands area. The study explores how the use of the IWB can support teachers in engaging learners to participate and interact during lessons. This study aims to contribute to enhancing learner participation and improving educational outcomes in overcrowded classrooms.

1.3 Research question

This study, therefore, aimed to address gaps in the existing literature by exploring how IWBs can improve learner engagement in large classrooms.

The main research question was therefore formulated as follows:

> *"How can the need for learner participation in a large classroom be addressed by using IWBs?"*

This question sought to understand whether IWBs can be effectively leveraged to reduce learner disengagement and foster a more interactive learning environment, particularly in the context of large primary school classrooms in South Africa.

The sub-research questions were:

1) What IWB tools (activities) can be used to improve engagement?
2) What strategies can be used to improve engagement in large classes?
3) What are Grade 6 learners' perceptions of the IWB?

1.4 Research aims/objectives

The primary aim of this study was to enhance learner participation in large primary school classes through the use of interactive digital tools, specifically IWBs.

Sub-aims of the study:

a) Increasing learner participation in a large class.
b) To apply IWBs as a tool for actively engaging learners in large learning environment.

1.5 Brief description of theoretical framework

This study made use of the Technological, Pedagogical, and Content Knowledge (TPACK) theoretical framework. Koehler and Mishra (2009) developed the TPACK framework based on Shulman's (1986) conceptualisation of Pedagogical Content Knowledge (PCK). According to TPACK, Pedagogical Knowledge (PK), Technological Knowledge (TK), and Content Knowledge (CK) are three interrelated domains that interact to create effective technology-based instruction.

A teacher's comprehension of the facts, ideas, and theories included in a discipline is referred to as their CK (Shulman, 1986). When utilising IWBs, a thorough understanding of CK is necessary, as it enables teachers to represent challenging concepts using technology more effectively. For instance, CK allows teachers in large classes to utilise IWBs to explain complex subject matter alongside visual aids and interactive simulations (Koehler & Mishra, 2009).

According to Koehler and Mishra (2009), a teacher's ability in pedagogical approaches, classroom management, and assessment techniques can be defined as their PK. PK is essential for fostering engagement, particularly in large classes where it can be difficult to retain learners' attention. To minimise disengagement in large classrooms, teachers with strong PK can ensure that IWBs are used to foster discussions, support interactive teaching, and create opportunities for collaborative learning (Koehler & Mishra, 2009).

Teachers' competence and abilities with digital technology refer to TK (Koehler & Mishra, 2009). For this study, TK is key to enhancing the use of IWBs. By incorporating multimedia content, PowerPoint assessments, and interactive activities, teachers with expertise in IWBs can enhance learner engagement in the classroom (Ersan, 2018).

Koehler and Mishra (2009) report that TCK is the way in which digital technology can change how certain content is presented. For instance, IWBs can be used to display interactive diagrams in science-related or Mathematics subjects, helping learners better understand abstract concepts. This is especially beneficial in large classroom contexts where there is a lack of learner engagement. Furthermore, Koehler and Mishra (2009) describe TPK as the manner in which the integration of digital technology into pedagogical practices can be facilitated. To achieve desired learning outcomes, teachers must be able to select and employ appropriate digital technologies. By creating a more engaging learning environment, IWBs can support group activities or interactive quizzes that promote participation, thus addressing the problem of disengagement in large classrooms. Furthermore, Shulman (1986) states that PCK refers to the knowledge that teachers use to effectively teach content to learners. With a high learners-to-teacher ratio presenting challenges to engagement, teachers in large classrooms must adapt their pedagogical practices to ensure space for PCK. Teachers should integrate ICT to keep learners engaged. The incorporation of CK, PK, and TK to promote effective technology-based teaching practices is known as Technological Pedagogical and Content Knowledge (Koehler & Mishra, 2009). It emphasises the importance of a well-rounded approach in which teachers can incorporate digital technology into their practices while considering the pedagogical approaches that will most effectively engage their learners.

The TPACK framework is particularly relevant to this study as it offers a framework for understanding how IWBs can be used to generate engaging learning experiences – even in large classroom settings where traditional approaches often fail to maintain learner interest. It provides insight into the technology, pedagogy, and content that must be carefully aligned to create effective learning environments. Consequently, the framework lays a solid foundation for understanding how IWBs can transform teaching practices to better engage learners in contexts where high learner-to-teacher ratios pose significant challenges. Önal (2017)

mentions that research has shown that teachers who successfully incorporate these knowledge areas can utilise IWBs to facilitate interactive and learner-centred learning activities, thus promoting greater engagement (Önal, 2017).

The effective use of the IWBs in large classrooms. The TPACK framework was applied. By focusing on the interactions between CK, PK, and TK, this study explored the potential of IWBs to enhance teaching practices that foster deeper learner engagement. This approach aimed to provide practical solutions to the issue of disengagement that is common in large classroom settings.

1.6 Research design and methodology

1.6.1 Design

The interpretive paradigm was used in this study. The interpretive paradigm which assumes that which assumes that reality is a social construction shaped by individuals' interactions with the world around them (Alharahsheh & Pius, 2019). According to Alharahsheh and Pius (2019), interpretivism integrates human interests into research. This paradigm is well-suited to the current study, as it aims to understand, acknowledge, and interpret the actions and experiences of both learners and teachers in their use of IWBs.

A qualitative approach was employed in this study. Qualitative research deals with the underlying qualities of subjective experiences and the meanings associated with phenomena (du Plooy-Cilliers, Davis & Bezuidenhout,201:173). Denscombe (2010:283) notes that qualitative data consist of words, whether spoken or written, and visual images. Research strategies such as case studies, grounded theory, ethnography, and phenomenology, along with research methods such as interviews, document analysis, and observation, are primarily associated with qualitative research (Denscombe, 2010:283).

The research design is based on action research. Denscombe (2010:125) describes action research as ideal for "hands-on" and small-scale research. It involves taking action, critically analysing practices, and collecting data to improve relevant practices (Denscombe, 2010:126). Furthermore, action research enables a researcher to plan a study systematically, prepare for data collection, analyse evidence, and develop conclusions and recommendations. Denscombe (2010:127) asserts that action research is both practical and applied, driven by the need to address real-world issues with practical solutions. He also emphasises that action research should be undertaken as part of the practice. Because the processes of research and action are tightly integrated into the research design of action research studies, employing this

approach in the current study may lead to practical solutions for integrating IWB within its context.

1.6.2 Site and participant selection

The research will be conducted at a quintile five primary school in the Cape Winelands district, Western Cape, Paarl. The school has 1,300 learners and 35 teachers, with average class sizes ranging from 40 to 45 learners. All classes exceed the teacher-learner ratio of 1:37 outlined by the Western Cape Education Department (WCED). In 2020, eight classrooms were equipped with IWBs and a classroom technology package that included an eBeam and a laptop computer. As discussed, large classes are often marked by learner disengagement. Therefore, the study site is appropriate, given that the prescribed teacher-learner ratio is exceeded and an IWB is readily accessible. However, there is limited knowledge regarding the specific context of the Cape Winelands district of Paarl in relation to existing literature on IWB usage.

The study engaged a sample of learners from a primary school in the Paarl area of the Western Cape. A *stratified random sampling* method was employed to create a rigorous selection process. This process involved categorising the learner population into strata by grade levels, from which participants were *randomly selected*, ensuring a representative cross-section of the school demographic.

Power dynamics and the potential for coercive participation have been addressed. An Independent third party was engaged to oversee the selection of participants. This measure aims to maintain ethical standards and reassure all participants that their involvement is voluntary and free from undue influence.

Six participants from grade six level were selected to participate in the interviews. The study made use of a stratified random sampling method to ensure a diverse range of experiences with IWBs was captured. The interviews were transparently documented to facilitate ethical review and uphold the study's integrity. The belief that IWBs are a solution to learner disengagement was critically examined throughout the research. While the study hypothesises that IWBs may enhance engagement, a balanced and empirical approach was taken to test this theory. Alternative explanations for engagement levels were explored, and the findings were interpreted through a critical and unbiased lens.

1.6.3 Data analysis

Qualitative data analysis is inductive: from the specific, detailed results to broad general categories. Data from the transcripts were coded, grouped into themes, and re-grouped into overarching categories or a general theory. Themes were formed and then developed into categories. In addressing concerns about achieving data saturation with six participants, it is important to clarify the study's strategic approach towards in-depth qualitative analysis. The study aimed to investigate learners' varied perspectives and experiences with using IWBs in

large class environments. The breadth of the sample size is not as important as the amount and quality of data collected from each participant in response to a narrowly focused research topic in a highly particular setting. The study made use of several data gathering such as in-depth focus group discussions (FGDs), direct observations, and individual reflections. These approaches were selected because they can provide deep, complex insights into how learners interact with IWBs. Due to the qualitative nature of the study, a limited number of experiences can be thoroughly explored to provide a comprehensive understanding of the phenomenon.

Additionally, the data analysis process was iterative, meaning that new themes and patterns were continually assessed for their comprehensiveness and depth. This iterative process actively evaluated the point of data saturation while ensuring that the analysis remained open to fresh ideas. Data saturation is considered to have been reached if recurring themes are identified and no new, relevant information consistently appears throughout the data sets.

1.7 Ethical considerations

All identities, organisations, individuals and schools are a primary concern among the ethical considerations in this study. In addition to obtaining consent from parents and guardians and establishing process for minors was followed, the study thoroughly addressed potential risks and articulated the potential benefits.

All research activities were conducted with the utmost respect for the participants' rights and dignity. Before the research commenced, permission was sought from the Faculty of Health and Wellness Research Ethics Committee at Cape Peninsula University of Technology (CPUT). Following this, the necessary permissions from the WCED were obtained.

Individual appointments were scheduled with each potential participant's parents to inform them about the study. Ample time was provided for parents to ask questions and address any concerns. Upon agreeing to participate, parents were given a consent form to complete.

1.8 Contribution of the study

This study builds on previous research by enhancing learner engagement in large classes through the use of IWBs. Additionally, it aimed to equip and support teachers with engaging tools for classroom integration. In alignment with van Wyk (2019:19), this study also aspired to contribute locally to the advancement of e-learning and the integration of ICT literacy at the primary school level.

1.9 Structure of the study

1.9.1 Chapter 1

Chapter 1 introduced the topic under investigation, focusing on the integration of IWBs to improve learner engagement in large primary school classrooms in Paarl, Western Cape. The preliminary literature review highlighted the challenges of teaching in overcrowded classrooms with learner-to-teacher ratios exceeding recommended limits, leading to learner disengagement and reduced teaching effectiveness. This research explored the potential of IWBs to foster interactive learning and enhance learner participation. The TPACK framework was presented as a foundation for integrating digital technology, pedagogical methods, and content. An action research approach was selected to provide practical solutions for teachers. This chapter outlined the research problem, objectives, and potential contributions toward enhancing learner engagement through the effective use of digital tools in South African primary education.

1.9.2 Chapter 2

Chapter 2 of the literature review examines how digital technology – especially IWBs – affects learner engagement in classrooms. With IWBs significantly increasing participation and engagement in large class sizes, South Africa's e-learning policy stresses the integration of digital technology into teaching and learning. The real-time feedback, multimedia integration, and collaborative learning made possible by IWBs enhance cognitive and emotional engagement through their combined effect. However, IWBs do have recognised technical difficulties and a high cost. Additional technologies covered include films, Plickers, and game-based platforms like Bamboozle. These resources enhance engagement, critical thinking, and active learning. By promoting anonymous involvement, Mentimeter – a web-based interactive tool – helps engage large classrooms. The chapter concludes by introducing the TPACK framework, which emphasises the need to combine content, pedagogy, and technology to create efficient and engaging learning environments.

1.9.3 Chapter 3

The methodology and design employed in the study are described in Chapter 3. Emphasising the need for an interpretive paradigm and a qualitative research design, it begins with a summary of the research approach. Using action research – which emphasises cyclical processes and practical solutions to enhance teaching strategies – the research site was a primary school in Paarl, Western Cape, where IWBs were already in use. All the participants were selected from the grade 6 level. With the aim of understanding how IWBs affect learner involvement, data collection techniques included FGDs, participant observations, and personal learner reflections. Qualitative coding where used to analyse the data involved.

Themes and categories were derived from the collected data. Triangulation, credibility tests, and ethical considerations – such as informed consent and the maintenance of participant anonymity – ensured the trustworthiness of the research. Ethical issues were rigorously addressed, including the protection of participant rights and a risk-benefit analysis.

1.9.4 Chapter 4

In chapter 4, the results of a study exploring the use of IWBs to improve learner engagement in large primary school classes in Paarl are presented. Three action research cycles were used in the study.

Each cycle demonstrates how the use of IWBs enhanced learner motivation and engagement. Despite technical difficulties, including load-shedding and poor internet connectivity, Cycle 1 showed an increase in engagement through the use of IWBs and Plickers cards. In Cycle 2, the learners were more comfortable and more involved, showing a preference for multimedia materials over conventional teaching approaches. Additional increases in engagement were noted in Cycle 3, particularly with the use of digital tools and films. According to the FGDs, the learners expressed favourable opinions of IWBs, indicating improved comprehension and enjoyment of the sessions. However, some dislikes were observed, including issues with brightness and technological problems. Overall, the study highlighted how effectively IWBs integrate TPACK to promote learner engagement.

1.9.5 Chapter 5

In chapter 5, the findings, interpretations and implications of the study, which explored how IWBs can improve learner engagement in large primary school classrooms, are discussed. To address the challenges posed by crowded classrooms, the study focused on employing IWBs to engage learners with digital tools. The use of IWBs was found to dramatically enhance motivation and learner engagement throughout three action research cycles.

The benefits of the IWBs were among the main conclusions. The learner engagement and participation increase when multimedia is integrated. Challenges such as WI-FI outages and load shedding were also reported in the data. Despite these drawbacks, IWBs significantly increased learner engagement in a large class setting, as learners became more comfortable and involved in class discussions.

Practical suggestions for teachers to enhance their digital literacy and align IWB activities with curriculum expectations are included in the chapter's conclusion. Future studies could examine the use of IWBs in smaller class sizes, investigate how learners engage across different age groups, and explore external factors that influence the use of technology in the classroom.

Attention now shifts to an exploration of existing literature to shed further light on the research topic.

1.10 Summary of the chapter

This introductory chapter outlined the research topic and the main elements of the research process. Specifically, Chapter 1 focused on the integration of IWBs to improve learner engagement in large primary school classrooms in Paarl, Western Cape. A preliminary review of the literature highlighted the challenges posed by overcrowded classrooms, where learner-to-teacher ratios often exceed recommended limits, resulting in learner disengagement and reduced teaching effectiveness. This research investigated the potential of IWBs to promote interactive learning and enhance learner participation. The TPACK framework was introduced as a theoretical foundation, emphasising the integration of digital technology, pedagogical strategies, and subject content. An action research approach was selected to develop practical, context-specific solutions for teachers. The chapter also presented the research problem, objectives, and the potential contributions of this study to improving learner engagement through the effective use of digital tools in South African primary education.

The next chapter will explore the existing literature to provide further insights into the research topic.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Teaching today involves the daily use of educational technology. The incorporation of educational technology into teaching and learning has been identified as a high priority by the South African government. The e-Education policy, for instance, stated in 2013 that every South African manager, teacher, and learner in the general and further education and training sectors should be capable of using educational technology – confidently and creatively – to develop the skills and knowledge necessary for lifelong learning, achieve personal goals, and actively participate in the global community (South Africa. Department of Education,2004:17). Numerous studies have demonstrated the benefits of integrating educational technology into educational settings (Brouse, Basch & Chow, 2011; Garrett, 2009). With educational technology, teaching and learning can be enhanced through various applications and digital tools, including IWBs, videos, video conferencing, digital tools, online testing, email groups, WhatsApp, Mentimeter, and gamification platforms like Baamboozle (Ishtaiwa & Shana, 2011).

One of the digital technological mediums that emerged in the 1990s was the IWB. Many studies have been conducted to assess the usefulness of this digital technology as its application in educational contexts spreads across the globe (Burden, 2002). The literature indicates that IWBs have favourable effects in educational settings, despite some acknowledged disadvantages. General perceptions of this technology suggest that it improves learner engagement and motivation, promotes classroom interaction, and helps teachers deliver lessons more efficiently (Grey, 2013; Smith, Higgings, Hall & Miller, 2005).

The literature review chapter is organised into several subsections, each addressing key topics related to the study's aim. It starts with an introduction, followed by an exploration of challenges associated with large classes and the importance of learner engagement and participation. Definitions of educational technology and a historical overview of its application in education provide context, with a specific focus on the IWB. This part delves into the advantages and disadvantages of IWBs, followed by discussions on integrating various digital tools into the classroom. The subsections of the study include the use of videos, game-based learning through platforms like Bamboozle, Plickers, and Mentimeter, each evaluated for its benefits and drawbacks. The theoretical framework TPACK is also introduced in this chapter, breaking it down into its core components: Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and the

overarching TPACK model. The chapter concludes with a summary synthesising the key insights from the literature.

2.2 Large classes

South Africa is known for its large classes (Isingoma, 2014). The teacher-to-learner ratio in most South African schools has changed from 1:40 in 2016 to 1:45 in recent years (Muthusamy, 2015:1). This is considerably larger than the DBE's definition of a "large classroom", which has a teacher-to-learner ratio of 1:31 (Muthusamy, 2015:1). West and Meier (2020:1) state that the South African education system faces a teacher shortage, resulting in overcrowded classrooms. Such large classes have numerous negative implications (Isingoma, 2014). Muthusamy (2015) agrees, noting that teachers encounter many obstacles when teaching in overcrowded conditions, which adversely affect both teachers and learners. Muthusamy (2015) elaborates that some of these negative implications include diminished learner engagement and participation.

Large classes may make it difficult for teachers to provide individual attention. However, IWBs can enhance engagement by facilitating deeper, more meaningful involvement with content. Interactive activities and multimedia manipulation on IWBs promote collaborative problem-solving and critical reflection. Smith et al. (2005) found that IWBs facilitate real-time feedback, debates, and the analysis, synthesis, and application of knowledge. These interactive learning experiences increase ownership of learning in overcrowded classrooms, bridging the gap between participation and engagement.

2.3 Learner engagement and participation

Henning (2012) refers to "learner engagement" as the amount of time and effort expended on tasks. Alternatively, when learners actively think about and participate in learning activities to enhance their academic performance, cognitive growth, moral and ethical development, psychological development, and practical competence, this is also termed learner engagement (Henning, 2012). Van Uden, Ritzen, and Pieters (2014) emphasise two fundamental components of learner engagement: emotional and behavioural. Given their interdependence and potential adverse effects on one another, it is crucial to distinguish between these two elements and understand each separately. In a classroom setting, learners' "sense of belonging" is referred to as emotional engagement. If learners are eager, interested in the class material, and maintain a positive learning attitude, they may be deemed emotionally engaged. In contrast, the term "behavioural engagement" primarily refers to learner participation. If learners participate in class, arrive on time, and fulfil expectations, including completing homework, they are considered behaviourally engaged. Teachers must be aware of these factors to address any gaps that may arise occasionally.

Moreover, Kuh (2009) presents a compelling argument for the significance of learner participation. He explains that the more learners engage with a subject, the more they will learn about it. Learners will understand the subject matter better the more they interact with teachers and receive feedback from them.

For effective facilitation of learner engagement, it is necessary for teachers to incorporate technology, as stated by Ersan (2018). Educational technology is now a crucial component of education, as it can assist teachers in actively involving learners in the learning process. It has become an essential tool in the classroom. Numerous studies have demonstrated the advantages of using educational technology in the classroom (Ersan, 2018; Önal, 2017; Erdener & Kandemir, 2019; Lamberth, 2012).

Learner engagement, according to Fredricks, Blumenfeld, and Paris (2004), is a complex concept that includes cognitive, emotional, and behavioural aspects. This emphasises that involvement requires greater engagement in learning activities, extending beyond mere participation. While emotional engagement reflects learners' curiosity and investment in the content, cognitive engagement involves learners actively striving to grasp difficult ideas and critically applying their understanding.

Digital platforms and IWBs, among other digital technologies, may create settings that support all facets of engagement. True learner engagement, as defined by Axelson and Flick (2010), entails cognitive, emotional, and behavioural involvement, whereby learners are encouraged to think critically and reflect on their development. While tools like Mentimeter and Plickers stimulate cognitive engagement by promoting problem-solving and discussion, teachers can employ interactive materials to elicit emotional responses. Thus, engagement is the active mental and emotional participation that enriches knowledge and enhances retention.

2.4 Definitions of educational technology

Januszewski and Molenda (2008) state that definitions of educational technology have been evolving as long as the field of technology itself and will continue to change. The term "educational technology" is widely used within the education profession and among the general population. The following scholars and authors have defined the term "educational technology":

- Januszewski and Molenda (2008) describe “educational technology” as the systematic and structured use of modern technology to improve the standard of education (in terms of effectiveness and excellence).

- By developing, utilising, and effectively managing suitable technological processes and resources, educational technology aims to facilitate learning and improve performance (Januszewski & Molenda, 2008).

2.5 History of technology in education

The history of educational technology can be traced back to early cultures that created pictographs or sign writing to record and communicate information. This is when tribal priests first organised bodies of knowledge, according to the history of "educational technology" (Saettler, 1990). Huang, Spector, and Yang (2019:19) suggest that tangible objects were utilised to support learning in the early stages of human history. For instance, an older person instructing a small child in hunting might use a real spear to teach the child how to aim and throw, possibly targeting a tree at first rather than an animal. The abacus, an early calculator used to keep track of inventories, required training as responsibility changed hands. Created around 3,000 BC, the abacus is considered the first computer since it provided a means to perform calculations (Lu & Liu, 2015).

The invention of the Gutenberg printing press in the fifteenth century made it possible for information and knowledge to be shared with a far larger population than before. By the sixteenth century, it was widely employed in Europe, and books began to dominate many learning environments. It is important to remember that printing press technology took roughly 100 years to become extensively used. The printing press changed social, political, and economic structures, as well as learning and education; however, it took a few hundred years for those changes to occur (Young, Quayle, Adams, Bertram & McMenamin, 2019:91).

In the nineteenth century, the first "educational films" were developed. Lu and Liu (2015) state that newsreels, travelogues, and scientific motion pictures were among the early precursors of instructional film. In 1902, Charles Urban displayed films depicting the development of plants, the appearance of a butterfly, and underwater vistas. These movies are believed to be the earliest instructional films (Lu & Liu, 2015). The authors further state that Thomas Edison was one of the first people to make films for schools. The 6 mm projectors and public television were also available during the 1900s (Young et al., 2019:92).

In 1927, the first public television demonstration took place (Lu & Liu, 2015). However, defining when the electronic television era began is nearly impossible. It is significantly harder to credit one person with creating this new media because so many contributed to its development.

According to Lu and Liu (2015), the Electronic Numerical Integrator and Computer (ENIAC) was introduced in Philadelphia in 1941. Constructed with approximately 17,468 electronic

vacuum tubes, ENIAC was the world's largest single electronic apparatus of its time, marking a major milestone in computer development. Lu and Liu further explain that the 1960s saw the introduction of computers in schools. In 1963, the mouse-pointing device received a patent, and the first versions of computer-aided design (CAD) software, including Sketchpad, were released (Lu & Liu, 2015).

The twentieth century saw a rapid increase in digital technologies to support learning, performance, and instruction, with television and animations in the first half of the century, and computers and the internet in the second half. The twentieth century can often be regarded as an era of educational technology.

The past few decades have seen rapid advancements in educational technology. In the twentieth century, technology facilitated accelerated learning and fostered collaboration between learners and teachers. According to Singh (2020), digital tools now integrated across the twenty-first-century educational system include blogs, emails, digital videos, computers, the internet, iPads, e-books, MOOCs, online courses, multi-link headphones, digital cameras, webcams, audio recording software, web-based learning platforms, walkie-talkies, IWBs, Jamboard, Mentimeter, Plickers, and smartboards, among other technologies, all of which play active roles in modern education.

2.6 Interactive whiteboard (IWB)

Xerox PARC in Palo Alto developed the first electronic IWB in the 1990s, and it entered school settings for the first time around forty years ago (Sjönvall, 2015).

An IWB combines a computer, an overhead data projector, and a whiteboard. The computer connects to the projector, which displays its image onto a large, touch-sensitive board. This board acts as an enlarged, interactive computer screen, allowing users to input directly with a finger or pen. This enables teachers and learners to move or modify items on the board easily, promoting interaction and engagement in the classroom.

In the classroom, an IWB can be used to demonstrate and annotate web resources and any computer application or file on the school’s network. IWBs also allowed multimedia, enabling the integration of video, music, and image files. With a connected scanner or networked PCs, learners’ work can be displayed on the IWB for class viewing and preserved as a record of their progress. Additionally, anything displayed on the board, including annotations, can be saved and printed, providing a convenient way to document and share classroom activities (Gage, 2008).

IWBs contribute to motivating learners to participate as well as enhancing teaching engagement. Studies indicate that IWBs allow learners to interact with digital content in real-time, thereby transforming abstract ideas into a tangible form through interactive manipulation. As learners actively participate in activities like problem-solving and multimedia exploration, this interaction enhances critical thinking, collaboration, and cognitive engagement (Hall & Higgings, 2005; Murcia, 2014).

IWBs also create dynamic, interactive learning environments that encourage active participation instead of passive learning. The IWB allows many different learning styles. The collaborative elements of IWBs also allow several learners to interact with materials concurrently, thereby encouraging peer conversation and teamwork (Glover, Miller, Averis & Door, 2007; Hall & Higgins, 2005).

Murcia (2014) states that qualities of IWBs underline their importance in not only improving participation but also enabling greater engagement through real-time feedback, tailored learning experiences, and opportunities for critical thought.

Classroom engagement tools like Plickers, IWB applications such as Jamboard and Mentimeter, and gamification tools like Kahoot and Bamboozle are all compatible with IWBs. These tools enhance interactivity, allowing teachers to create dynamic and engaging learning experiences on the IWB.

2.6.1 Advantages of the IWBs

The usage of “IWBs” benefits both teachers and learners in various ways. The IWB may enhance learner participation. Obaid (2022:57) describes how digital technology for IWBs enhances the effectiveness of whole-class teaching. In a related study, Stroud, Drayton, Hobbs, and Falk (2014:41) concur and mention that the IWB boosts teachers' perceptions of learners' participation in class discussions.

Secondly, studies have shown that the IWB can be connected with various digital technologies, enabling teachers to utilise a range of tools more effectively. Stroud et al. (2014:41) support this idea and claim that the IWB allows teachers to incorporate multimedia elements into their classes, such as YouTube videos, music, and written text. Al-Faki and Khamis (2014) also claim that the IWB permits the simultaneous use of several resources.

Thirdly, the IWB allows teachers to take and save notes directly on the board during lessons, providing a valuable time-saving strategy. By saving their annotations, teachers can reuse the same information across multiple classes, allowing them to move through material more

efficiently (Toscu, 2013). Obaid (2022:57) supports this, noting that IWBs enable teachers to plan and organise their lessons more effectively, enhancing overall lesson structure and delivery.

Fourthly, the IWB's size provides teachers and learners with a large display. Al-Faki and Khamis (2014) agree and claim that the IWB's mobility and large display make it easier for learners to see the board. Maryam et al. (2019:79) and Ersan (2018) concur that using the IWB and its sizable display promotes learner engagement and interaction with the teacher. The IWB allows the teacher to move among learners while instructing. An IWB also allows for interactive internet browsing while working directly at the board with a pen or finger. Gage (2006) agrees and states that this is especially beneficial for displaying and working with a website in front of a large group of learners. All the learners can see the page simultaneously, keeping them focused on the same content.

Lastly, the IWB allows teachers to bring external content and diverse experiences into the classroom, enriching learning with a wide array of resources. The IWB enhances learner engagement by allowing interaction with the material displayed on the board. Teachers can instantly present videos or virtual tours, giving learners a window into places they may never have visited, such as museums or foreign countries, by simply entering a location into the search bar. Stroud et al. (2014:41) highlight that learners enjoy the IWB for this reason, as it allows them to explore new and exciting places, making learning more immersive and engaging.

Studies have indicated that the IWB has a generally positive impact on learners. The use of IWBs in classroom activities has increased learner engagement (Stroud et al., 2014). Learners now actively participate in class discussions and share their stories, according to Toscu (2013).

2.6.2 Disadvantages of IWBs

Similar to other new educational technological tools, IWB technology has downsides and is criticised by some scholars, even though more and more teachers are using it in the classroom.

The IWB is susceptible to educational and technological problems like any other technology. There could be issues with the projector, the network connection, or the board itself. Moreover, Hall and Higgins (2005) point out that connectivity problems can periodically disrupt lessons and reduce learners' time with the teacher. In agreement, Toscu (2013) observes that the IWB occasionally experiences technical problems that obstruct certain programmes, such as

network issues, causing the screen to blur. This may result in frustration for both teachers and learners.

Another issue with IWBs is their high cost. Compared to competing educational technologies, such as slide projectors, the IWB is significantly more expensive (Toscu, 2013). The price per unit ranges from R16,000 to R25,000. As a result, implementing IWBs in schools typically necessitates government assistance. The installation and upkeep of IWBs are costly. According to Jones, Kervin, and McIntosh (2011), IWB technology places a financial burden on schools that wish to purchase it. Additionally, IWBs are fragile. Teachers and learners may use the equipment extensively, which means that projector bulbs must be replaced, and the equipment requires regular servicing. Since teacher training is time-consuming and expensive, it is common for teachers to lack the knowledge necessary to use the IWB effectively in the classroom.

Although the IWB's physical size provides learners and teachers with a large display area and enhances whole-class instruction, the speakers that accompany the equipment may need to be louder for a large class to hear (Toscu, 2013). Additionally, depending on the teacher's height, the board's height may pose a drawback for some educators.

2.7 Integrating digital tools in the classroom

In addition to being stand-alone digital technologies, Plickers, Bamboozle, and Mentimeter are all digital tools covered in this section that can be readily integrated with IWBs. When combined with IWBs, these tools enhance engagement and interaction by enabling learners to actively participate in lessons through the interactive features of the board. The functionality of IWBs is maximised through this integration, increasing their adaptability and effectiveness in promoting learner participation and engagement in large classroom environments.

2.7.1 Videos

Sherin and van Es (2005:478) note that since the 1960s, when portable video technology became accessible, videos have been used in educational contexts. Since then, various applications have developed, including micro-teaching, interaction analysis, and video-based situational learning.

Prayudha (2021) defines a "video" as a recording that captures images or real-life objects with accompanying sound, commonly referred to as "audio-visual media". This medium is widely used in teaching and learning because it enhances students' interest by allowing them to see and hear simultaneously. Although learners do not experience these visuals and sounds

directly from the source, intermediary devices such as TVs, laptops, computers, or mobile phones effectively convey the content.

Teachers can effortlessly display videos featuring three-dimensional (3D) visuals, animations, and new concepts, making complex ideas more accessible. They can also incorporate experiments that are challenging to conduct in a classroom setting or that involve significant risk. Additionally, videos provide a dynamic way to present subjects such as literature, music, history, and other engaging topics directly to learners (Keppens, Consuegra, Goossens, Maeyer & Vanderlinde, 2019:).

As a form of digital technology, videos offer opportunities to enhance pedagogical engagement by increasing the immersion and cognitive stimulation of learning. Studies indicate that videos can captivate learners by graphically presenting challenging topics, thereby fostering not only understanding but also curiosity and critical thinking. By presenting real-world events, videos can inspire emotional involvement and allow learners to relate to and find relevant material (Lackmann, Léger, Charland & Aubé, 2021).

2.7.2 Advantages of Videos

Prayudha (2021:5) states that videos are the best communication method for the younger generation, who enjoy watching videos online. This format may be the ideal way to demonstrate new concepts. Kriswinardi, Nitiasih and Dambayana (2017:5) assert that research has shown learners believe accessing video media will enhance their motivation to learn. According to Prayudha (2021:5), learners are found to be engaged and immersed in videos. Therefore, video is essential for creating an immersive and engaging learning experience and should be incorporated into the classroom as soon as possible.

2.7.3 Disadvantages of videos

According to Kriswinardi et al. (2017:5), studies indicate that teachers sometimes show videos of subpar quality, which can reduce learners' focus and engagement, hindering their understanding of the topic. Sachev and Kaur’s (2014) theory supports this, suggesting that low-quality videos can be distracting and prevent learners from actively participating in learning, which is ultimately counterproductive.

Another potential disadvantage is that not all schools have the necessary equipment and financial resources, and teachers may lack the skills to use these digital technologies in the classroom.

2.8 Plickers

“Plickers” is a digital technology tool introduced in 2013 (Chng & Gurvitch, 2018; McCargo, 2017). It employs "paper-clickers" to deliver quick questions and feedback to students, providing a simple, efficient formative assessment tool that enhances learning (Chng & Gurvitch, 2018; McCargo, 2017). Elmahdi, Al-Hattami, and Fawzi (2018:182) describe Plickers as a technology-based system that uses paper-coded cards measuring 5.5 by 5.5 inches, each printed with a four-sided QR code in the centre. Each side of the QR code corresponds to answer choices (A, B, C, or D), while the corners display different card numbers. Teachers display a question and possible answers via a projector or IWB, allowing students to respond by holding up their cards (Wood, Brown & Grayson, 2017:17). Plickers offers an innovative, effective audience response system for classrooms.

Beyond simple participation, Plickers enhances engagement by facilitating real-time formative assessment that fosters critical thinking. Studies suggest that Plickers promotes active learning by allowing teachers to ask complex questions that encourage thoughtful responses rather than quick answers. Its anonymous response system reduces stress, encouraging all students to participate, which contributes to an inclusive environment. This atmosphere encourages learners to engage more actively in discussions, collaboratively analyse outcomes, and reflect on their knowledge, supporting both cognitive and social engagement (Kent, 2019).

Figure 1: Example of a Plickers card

Source: Wood et al. (2017)

2.8.1 Advantages of Plickers

Chng and Gurvitch (2018) note that Plickers is a free, user-friendly tool available at www.plickers.com, allowing teachers to collect data for formative and summative assessments in real-time without requiring learners to have any additional hardware. Additionally, Elmahdi et al. (2018) highlight that Plickers offers 63 card patterns, downloadable for free as PDFs or available for purchase in an enhanced package. The researchers emphasise that teachers manage the tool’s other operational aspects. Wood et al. (2017:2) agree, observing that Plickers' low cost, simplicity, and reusability help overcome typical challenges of electronic

plicker-driven such as learner expenses, battery issues, missing devices, and connectivity problems.

According to McCargo (2017), the advantage of adopting educational technology in the classroom, such as Plickers, is that it removes the need for teachers to record learners' responses on paper, which is often misplaced. To assist teachers and learners, Plickers saves the learners' response data online. Not only does this simplify the process for the teacher, but it also allows learners to remain anonymous while seeing the outcomes of their responses immediately on the screen (McCargo, 2017).

Wood et al. (2017) further explain that Plickers, as an active quiz in the classroom, can boost participation and provide the teacher with the opportunity to evaluate each learner's progress in terms of preparation, attendance, formative learning, and educational outcomes. Alternatively, Kuh (2009:684) states that Plickers ensures two-way communication between each learner and the teacher, helping to keep learners attentive and involved throughout the lesson.

Studies indicate that Plickers could be used for official learner evaluation tasks, such as exit tickets or warm-up exercises. Each learner must participate in choosing an answer. The teacher uses the live view tab to project the answers from their digital device onto the screen after viewing the percentage of the class and how each learner performed on the question (Damick, 2015).

2.8.2 Disadvantages of Plickers

In addition to offering various advantages, some studies have highlighted the disadvantages of using Plickers in the classroom. Masita and Fitri (2020:318) indicate that research has shown that a teacher should utilise an internet connection, a smartphone, a laptop, and a projector for this application. Elmahdi et al. (2018:189) concur, stating that teachers may encounter difficulties using Plickers in classrooms due to limited technology resources and internet connectivity. Furthermore, studies have indicated that teachers must prepare by downloading the app on their smartphones and installing it before using it offline. An internet connection is required to simultaneously operate a smartphone, laptop, and projector with the programme. Consequently, this programme cannot be used if all devices are unavailable (Elmahdi et al. 2018:189).

Additionally, this programme is not fully accessible. If a teacher wishes to utilise the programme for free, it can only be used for five questions. To maximise its potential, the

teacher must upgrade the application by paying for a year's subscription (Masita et al. 2020:318).

Research indicates that there are challenges associated with using Plickers for formative assessment. For instance, when Plickers is introduced in the classroom for the first time, some learners may be unfamiliar with the tool, potentially leading to frustration (Masita et al. 2020:317).

2.9 Game-based learning: Bamboozle

Sharma and Sharma (2023) have stated that gamification has started to take over the world. Research further shows that nearly 70% of learners say gamified classrooms and learning experiences are preferable to traditional educational approaches, with motivation and engagement gains as the main draws. A learning approach known as "game-based learning" uses materials presented as games. According to Sharma and Sharma (2023), games are a type of media used to motivate learning, allowing learners to play while simultaneously learning.

Bamboozle is an online educational technology platform that teaches through games. It is an interesting game-based application that enables learners to collaborate and participate. Bamboozle is a web-based tool for designing entertaining games that promote the idea that learning should be enjoyable, aid teachers in reinforcing concepts, and involve all learners in the learning process (Rosmaladewi, Abduh, & Basri, 2020). Rosmaladewi et al. (2020) state that Bamboozle requires no account creation from the learners. Bamboozle can be played in the classroom on an IWB, both face-to-face and online.

By motivating not only participation but also thorough teaching involvement, Bamboozle is an online learning tool that engages learners through game-based learning. Studies on game-based learning environments suggest that platforms like Bamboozle improve collaboration and competitiveness, both of which are fundamental for fostering cognitive, emotional, and social engagement. Through team-based exercises, Bamboozle promotes critical thinking and problem-solving in a competitive but motivating setting. Together with emotional involvement motivated by the thrill of competition, this cooperative element helps to maintain constant attention and enhance long-term memory (Faiella & Ricciardi, 2005).

Gamified platforms have shown to boost participation and engagement. This combination of cognitive and emotional involvement enables education to become an interactive and dynamic process that supports both individual and group learning outcomes (Faiella & Ricciardi, 2015).

2.9.1 Advantages of game-based learning: Bamboozle

The Bamboozle website is valuable and accessible even without creating an account. Krisbiantoro (2020) mentions that Bamboozle are easy to use, as it can be used for both online and offline learning. Furthermore, Krisbiantoro (2020) asserts that Bamboozle facilitates continuous study, improves learner outcomes, and is both effective and enjoyable.

2.9.2 Disadvantages of Baamboozle

Studies have shown that Baamboozle offers numerous advantages; however, certain challenges may arise, such as the need for a stable internet connection, limited access to necessary equipment in some schools, and inconsistent participation from all learners (Karademir, Yaman, & Saatçioğlu, 2020:455).

2.10 Mentimeter

“Mentimeter” is an interactive web-based presentation tool that engages learners in large classes. It accommodates an unlimited number of participants and offers a variety of question types. Mentimeter has a higher potential for eliciting responses from learners and allows limitless participation (Musliha & Purnawarman, 2020:320). Mohin, Kunzwa, and Patel (2022:48) describe Mentimeter as a web-based audience response system, similar to TurningPoint, designed to encourage learner engagement and participation in the classroom. Little (2016) agrees, noting that Mentimeter effectively fosters learner’s involvement. Additionally, Mohin et al. (2022:48) recommend that Mentimeter contribute to a more dynamic and inclusive classroom environment.

Not only is Mentimeter an interactive presentation tool, but it also promotes deeper cognitive and emotional involvement, thereby enhancing engagement among learners. Studies showed that the anonymity provided by Mentimeter helps learners who may be reluctant to participate in traditional classroom settings feel more comfortable sharing their views, thus increasing emotional involvement. By encouraging learners to consider peer responses and engage in meaningful discussions, the technology fosters critical thinking. This collaborative learning environment, where learners actively participate in debates, enhances their knowledge and interaction with the material while also promoting social engagement (Pichardo et al., 2021; Mohin et al., 2022).

Mentimeter is particularly effective in large classes, where learner involvement can be challenging. Its features – word clouds, multiple-choice questions, and live polls – help to break up lectures and promote active learning by involving learners in the conversation. These tools ensure that learners engage cognitively and emotionally throughout the session, thus fostering inclusion and creating a more dynamic learning environment (Mohin et al., 2022).

2.10.1 Advantages of Mentimeter

According to Vallely and Gibson (2018), studies have shown that the Mentimeter tool is easy and quick to use, not only for teachers but also for learners. Vallely and Gibson (2018:5) further indicate that Mentimeter can be utilised as a learning and assessment tool and can help identify any misconceptions that learners may have.

Little (2016) states that Mentimeter enhances learner engagement and participation, improving classroom interaction. Vallely and Gibson (2018:5) agree, noting that Mentimeter has been shown to improve learner engagement. Rudolph (2018) adds that studies indicate Mentimeter can significantly boost classroom participation. Hill and Fielden (2017) further support this, emphasising that these elements are essential for creating an effective learning environment.

2.10.2 Disadvantages of Mentimeter

Studies indicate that Mentimeter is a user-friendly and versatile tool that can enhance teaching and learning in large classes (Musliha & Purnawarman, 2020:320). However, once learners submit their responses on Mentimeter, they cannot retrieve or modify them, which can make it challenging to identify learners who may need additional support, as responses are submitted anonymously (Musliha & Purnawarman, 2020:320).

2.11 Theoretical framework: Technological Pedagogical and Content Knowledge (TPACK)

This study made use of the Technological, Pedagogical, and Content Knowledge (TPACK) theoretical framework. This study explores the potential benefits of IWBs in minimising learner disengagement in large classroom settings. The TPACK framework was developed by Koehler and Mishra (2009) and is based on the conceptualisation of Pedagogical Content Knowledge (PCK) by Shulman (1986). According to TPACK, Pedagogical Knowledge (PK), Technological Knowledge (TK), and Content Knowledge (CK) are three interrelated domains that interact to create effective technology-based instruction. Furthermore, TPACK is seen as a dynamic framework that describes the knowledge instructors must rely on to design and implement curricula while guiding their learners' thinking and learning with digital technology across various subject areas. The TPACK framework builds on Shulman’s concept of PCK to address effective teaching with technology. Developed through several publications, Koehler and Mishra’s (2009) work provides a comprehensive explanation of the framework, emphasising that teaching with technology requires advanced skills and understanding. Koehler and Mishra (2009) cite numerous academics who contributed to the evolution of this concept, which has been referred to by various terms – such as integration literacy, e-PCK, technological content

knowledge, or ICT-related PCK – before being widely recognised as "technological pedagogical content knowledge" or TPACK.

The TPACK model combines three areas of knowledge: content knowledge, pedagogical knowledge, and technological knowledge. The model comprises three elements: the teacher's understanding of content, pedagogy, and technology (see Figure 2). The interactions between these three interconnected elements are equally crucial to the model.

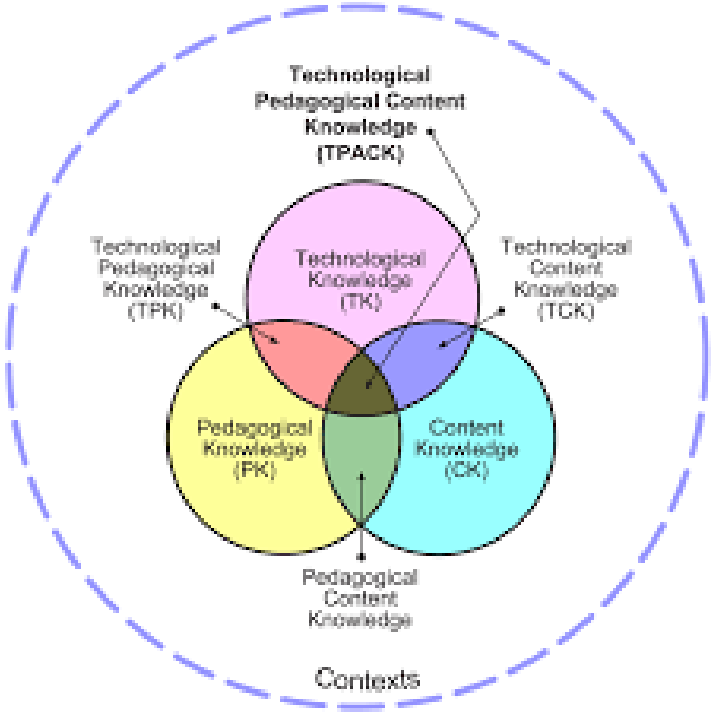

Figure 2: The TPACK framework and its knowledge components

Source: Koehler and Mishra (2009:63)

2.11.1 Content Knowledge (CK)

“Content Knowledge” (CK) refers to a teacher's understanding and proficiency in the subject they teach (Koehler & Mishra, 2009:63). The importance of teachers having subject-matter expertise lies in the fact that this knowledge, according to Shulman (1986), encompasses the facts, concepts, and theories of any discipline. In appreciating art, for instance, such details might include information about artists and their backgrounds (Koehler & Mishra, 2009:63). Knowledge of the subject matter being taught constitutes CK. Furthermore, CK is defined as the "knowledge regarding the actual subject matter that is to be learnt or taught" (Schmidt et al., 2009:125). Teachers need to be knowledgeable about the materials they are teaching.

The TPACK framework offers a useful approach for integrating technology, pedagogy, and subject knowledge. Understanding and applying TPACK will help teachers design lessons that not only promote cognitive, emotional, and social interaction but also enhance participation.

Strong TK, for example, enables teachers to select digital tools, such as IWBs or online platforms, that facilitate interactive problem-solving and collaboration, thereby improving the cognitive engagement of their learners. Moreover, while cooperative elements foster social interaction among learners, the personalisation features within these tools can encourage emotional involvement by making content more relevant (Koehler & Mishra, 2009).

By incorporating subject matter, pedagogy, and technology in this way, teachers move beyond surface-level engagement, thus fostering continuous and meaningful classroom interaction. This comprehensive strategy ensures that learning activities are not only interactive but also contribute to deeper understanding and retention (Koehler & Mishra, 2009).

2.11.2 Pedagogical Knowledge (PK)

The teacher's in-depth understanding of the teaching and learning processes is referred to as “Pedagogical Knowledge” (PK) (Koehler & Mishra, 2009:64). When teachers possess this knowledge, their lesson plans and assessments can more effectively reflect how learners learn (Koehler & Mishra, 2009:63).

According to Koehler and Mishra (2009:63), PK includes a teacher’s understanding of how to effectively plan, implement, and evaluate learning activities, along with knowledge of how learners learn. Schmidt et al. (2009:125) agree, noting that PK involves instructional strategies and includes expertise in classroom management, conducting assessments, and facilitating learner learning.

2.11.3 Pedagogical Content Knowledge (PCK)

The connection between the CK and PK domains is known as “Pedagogical Content Knowledge” (PCK). PCK focuses on critical elements such as instruction, learning, curriculum evaluations, and the creation of learning-friendly environments (Koehler & Mishra, 2009:63). To achieve a deeper understanding, PCK employs various learning strategies and scaffolding (Koehler & Mishra, 2009:64). Schmidt et al. (2009:128) acknowledge that PCK varies across different subject areas, as it integrates pedagogy and content to identify and enhance teaching methods within those subjects.

2.11.4 Technological Knowledge (TK)

According to Schmidt et al. (2009:125), “Technological Knowledge” (TK) involves an understanding of a wide range of technologies, from low-tech tools like pencil and paper to high-tech tools like digital video, the internet, and IWBs. Koehler and Mishra (2009:65) similarly define TK as knowledge of accessible technologies and the ability to use them effectively in a

lesson. TK includes the skills necessary to operate specific technologies and familiarity with advanced tools, such as digital video and the internet. In the context of digital technology, TK encompasses understanding operating systems, computer hardware, and proficiency with common office software, including word processors, web browsers, and email clients.

2.11.5 Technological Content Knowledge (TCK)

The connection between TK and CK is called “Technological Content Knowledge” (TCK). TCK uses technology in a subject area to promote profound and long-lasting learning (Koehler & Mishra, 2009:63). Teachers must comprehend the best unique technology appropriate for the topic (Koehler & Mishra, 2009:65). As stated above, TCK refers to the knowledge of how to use technology within a specific area.

2.11.6 Technological Pedagogical Knowledge (TPK)

The integration of TK and PK is referred to as “Technological Pedagogical Knowledge” (TPK). TPK encompasses the knowledge required to select appropriate technology for teaching (Koehler & Mishra, 2009:63), which involves a deeper understanding of choosing the optimal technology to support learning specific subject matter. According to Schmidt et al. (2009:125), TPK also includes the awareness that using technology can change instructional methods and understanding how various technologies can be employed effectively in teaching.

2.11.7 Technological, Pedagogical, and Content Knowledge (TPACK)

These three knowledge areas – TK, PK and CK – interplay as TPACK (Koehler & Mishra, 2009:63). Understanding how subject matter might be portrayed using technology is necessary for implementing TPACK in every class where a teacher uses technology. TPACK focuses on using pedagogical methods to teach material while integrating practical teaching with technology (Koehler & Mishra, 2009:67). The idea that TPACK relates to the skills teachers need to incorporate technology into their instruction in any subject or content area is emphasised and developed by Schmidt et al. (2009:125).

Schmidt et al. (2009:125) assert that teachers should understand the complex relationships between the three essential components of knowledge – CK, PK, and TK – when teaching learners using appropriate pedagogical strategies and technological advancements. According to the TPACK framework, there are individual and collective responsibilities for content, pedagogy, technology, and teaching environments (Koehler & Mishra, 2009:63). Technology-enhanced instruction requires striking and maintaining a balance between these constituent parts. In studies of the TPACK framework, the interaction of PK, TK, and CK has received extensive attention (Koehler & Mishra, 2009:67). Consequently, the regular use of any ICT tool

in the classroom necessitates a thorough understanding of both how it functions and the purposes it serves (Mishra & Koehler, 2009:64). The selected theoretical framework will provide a solid basis for considering how TK, PK, and CK should be integrated when incorporating technology into the classroom, especially as the mitigation of learner disengagement is explored.

2.12 Summary of the chapter

This literature review provides a broad overview of research on the use of technology in education. Digital technology has given education a whole new meaning, and our educational system has undoubtedly been revolutionised by ever-advancing technology. We can now prepare learners for lifelong learning, which necessitates innovative methods of education that incorporate technology into their daily lives. It is widely acknowledged that a well-rounded education offers a springboard to personal achievement, placing learners on a path of lifelong learning and preparing them to excel in an ever-changing world. Through education, individuals can broaden their minds, welcome new ideas and opportunities, and build better lives for themselves and their communities.

Digital technology has transformed education. The IWB and digital platforms such as Plickers have revealed that these digital technologies have improved social, emotional, engagement and participation in the classroom. Critical thinking, emotional connection and teamwork depend on deep learning. These tools provide engaging opportunities to enhance. For example, Fredricks et al. (2004) emphasised the importance of cognitive and emotional involvement in enhancing academic excellence. Learning environments are often created with a combination of digital technologies. Moreover, this combination fosters a greater engagement and improved long-term learning (Fredricks et al., 2004).

Studies have been conducted across various disciplines to examine how IWB technology may impact classroom engagement and participation. Research indicates that evidence on the use of IWBs to enhance learner engagement in large classes at primary schools in Paarl, Western Cape, is limited. Due to the lack of empirical evidence supporting the benefits of IWBs for classroom engagement in large classes in Paarl, this study aims to investigate the contribution of IWBs to classroom engagement in a primary school.

In conclusion, the TPACK framework provides a useful lens through which to consider what knowledge teachers should possess and how they may acquire this knowledge to integrate technology into their teaching. This study employed the TPACK framework as a theoretical basis to address the research topic and its sub-questions.

The next chapter describes the methodology that was used in this study, including the participants and settings, as well as instruments, data collection, and data analysis procedures.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

Chapter 1 provided a summary of the research technique, while Chapter 3 offers a comprehensive explanation of the research design and methodology utilised in this study. This chapter describes the approach chosen for the research, as well as thoroughly addressing its rationale with detailed steps taken to ensure that the methodology and the study's objectives are in sync and ultimately aimed at achieving the most effective results.

The following is the chapter's structure: It begins with an introduction, setting the stage for the discussion of the research paradigm, approach, and design. Then we examine the details of site and participant selection, providing the rationale behind these choices. The data collection methods and the subsequent processes of data analysis also include a focus on qualitative data analysis, which is explained. The credibility and reliability of the research are also addressed in this chapter. The researcher's role is outlined, followed by a discussion on the ethical considerations. A thorough analysis of the balance between benefits and risks. Finally, the chapter concludes with a summary, encapsulating its key points and findings.

3.2 Research paradigm, approach, and design

Positivism, interpretivism and critical realism are the three main research traditions. du Plooy-Cilliers et al. (2014) state that these traditions provide systematic processes for gathering and analysing data using appropriate collection and analysis techniques.

This study made use of an interpretive paradigm. Alharahsheh and Pius (2019:41) explain that the interpretive paradigm focuses on thoroughly exploring the variables and contextual factors that influence a situation. This paradigm, in accordance, is adopted to understand, acknowledge, and interpret the actions and experiences of both the learner and teacher, particularly in their usage of digital tools and technology.

Littlejohn and Foss (2009) mention that the interpretive approach search for the understand the world through the direct experience of phenomena. Similarly, du Plooy-Cilliers et al. (2014:172) affirm that interpretivism aims to understand and make sense of meaningful experiences and social actions.

This research employed a qualitative design, which focuses on exploring the underlying qualities of subjective experiences and the meanings associated with phenomena (du Plooy-Cilliers et al., 2014:173). According to Denscombe (2010:283), qualitative data encompass words, whether spoken or written, as well as visual images. Qualitative research is often

associated with strategies such as case studies, grounded theory, ethnography, and phenomenology, and methods including interviews, document analysis, and observation (Denscombe, 2010:283). For this study, FGDs and observations were utilised as data collection methods to gain an in-depth understanding of multiple perspectives and realities.

The research design is based on action research. Denscombe (2010:125) describes *action research* as ideal for "hands-on" and small-scale studies. It relies on taking action, critically analysing practices, and collecting data to improve relevant practices (Denscombe, 2010:126). Furthermore, action research enables a researcher to plan a study systematically, prepare for data collection, analyse evidence, and develop conclusions and recommendations. According to Denscombe (2010:127), action research is practical and applied, driven by the need to find real-world solutions. He also asserts that action research must be undertaken as part of the practice. As the processes of research and action are tightly integrated in action research studies, the use of action research in this study may propose practical solutions for integrating digital tools and devices within its context.

Denscombe (2010:125) further identifies four defining characteristics of action research:

I. Practical nature: Dealing with real-world problems.

II. Change: Change is viewed as an essential component of study to solve real-world issues and learn more about phenomena.

III. Cyclical process: Initial research findings offer potential directions for change, which are then put into practice.

IV. Participation: The most critical participants in the research process are practitioners.

Denscombe (2010:129) notes that action research is frequently used to enhance the level of professional self-development. He further explains (2010:229) that this aligns with the concept of professional self-development, emphasising the importance of a continuous pursuit of improvements in one's practices and methods. A cyclical process should be followed.

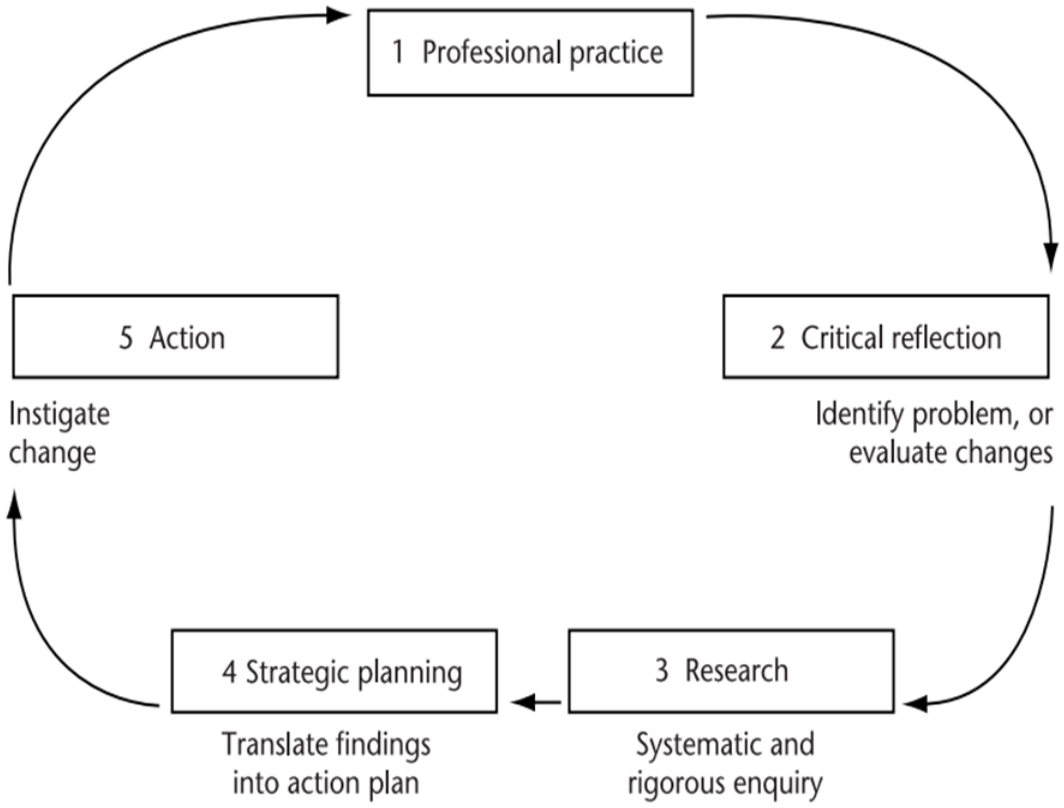

Figure 3: The cyclical process of action research

Source: Denscombe (2010:129)

The cycle of inquiry in action research is essential because it (1) directly informs and enhances practice and (2) remains an ongoing, iterative process. Critical reflection by the practitioner is not limited to identifying "problems"; it also involves assessing and building upon improvements that have already been achieved. However, it is important to acknowledge that while this approach is ideal, action research often restricts itself to isolated, one-off studies. For this study, the researcher adopted the cyclical action research method proposed by Denscombe in 1999.

The cyclical nature of action research played a central role in both data collection and analysis. Each action research cycle involved reflection on the outcomes of the previous cycle, allowing for adjustments to teaching strategies and the use of the IWB in the classroom. For instance, after technical challenges were identified in Cycle 1, subsequent cycles incorporated solutions, such as the use of more intuitive digital tools like Plickers. This iterative approach ensured that the research remained responsive to real-time feedback from both teachers and learners, leading to practical insights into how IWBs can enhance engagement in large classrooms (Kemmis, McTaggart & Nixon, 2014).

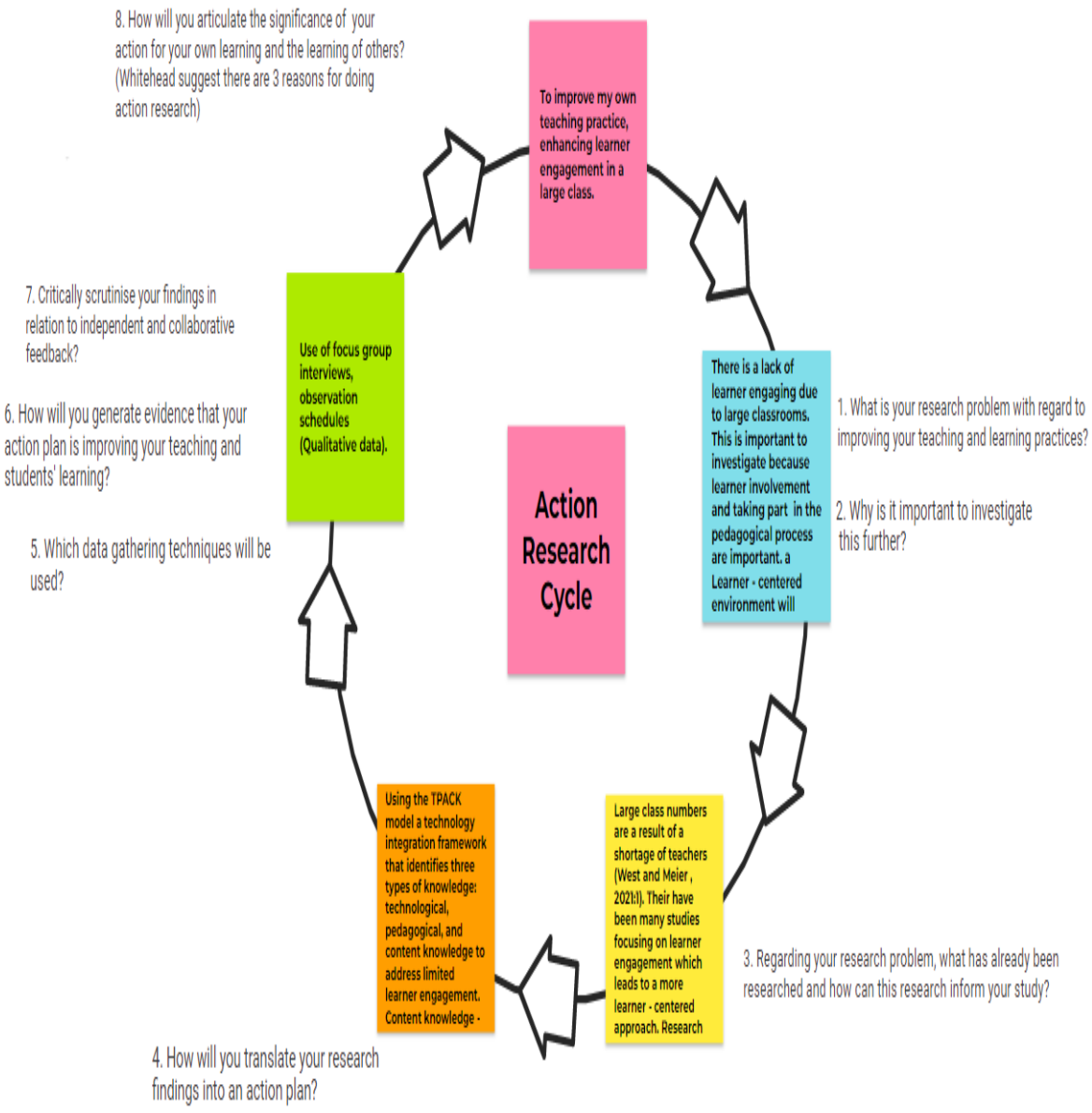

Figure 4: Action research cycle

Source: Denscombe (1999:126)

3.1.1 Site selection

The research was conducted at a quintile five primary school in the Cape Winelands district, Western Cape, Paarl. The school has 1,300 learners and 35 teachers, with average class sizes ranging from 40 to 45 learners. All classes exceed the teacher-learner ratio of 1:37 as outlined by the WCED. In 2020, eight classrooms were equipped with an IWB and a classroom technology package that included an eBeam and a laptop computer. As previously discussed, large classes are characterised by learner disengagement. Therefore, the study site is relevant, as the teacher-learner ratio is surpassed, and there is readily available access to an IWB. Regarding existing literature on IWBs, very little is known about the context of the Cape Winelands district of Paarl in the Western Cape.

3.1.2 Participant selection

The study focused on a sample of learners from a primary school in the Paarl area of the Western Cape. A stratified random sampling method was employed to ensure a rigorous and representative selection process. This involved categorising the learner population into strata based on grade levels, from which participants were randomly selected, creating a cross-section of the school demographic.

The study made use of a small sample size. Six participants were selected in grade 6 level. Smaller sample sizes allow for iterative cycles of reflection, and action research benefits from this (Creswell & Poth, 2018). Furthermore, the small sample size allows for an in-depth exploration of individual experiences and gaining meaningful insights into the use of IWBs in large classrooms. The findings were not to generalise but to provide a deep understanding of learner engagement within a specific context.

An independent third party was engaged to oversee participant recruitment to address potential power dynamics, particularly if the investigator also serves as a teacher. This action upheld ethical standards, ensuring that all participation was voluntary and free from undue influence.

Six random learners were selected through stratified sampling. The study made use of an empirical approach to test the hypothesis that IWBs could enhance engagement. All the findings and alternative explanations for different engagement levels were considered. A Critical and unbiased lens was used to analyse the findings.

All research activities, including observations and interviews, were meticulously planned. All the ethical guidelines were followed and the consent forms were signed by the learners and their guardians well before the data collection began.

A comprehensive approach was used to select participants. Stratified random sampling was applied to categorise the learner population of a primary school in the Paarl district of the Western Cape into strata based on grade levels. Random participants were then selected from these strata, ensuring a representative cross-section of the school's demographics. This method reinforced the validity and reliability of the study by providing a balanced and inclusive sample.

The stratified random sampling method ensured representation from different grade levels and varying levels of familiarity with IWBs. This approach was critical because the diversity of technology among learners was included. Patton (2015) states that stratification helps to provide a holistic view.

The aim behind the selection method was to capture a diverse range of experiences with IWBs and to comprehensively address the research question. All the phases of the participant recruitment were independently done by the researcher. There was no involvement from other teachers during the selection phase. The process included distributing consent forms and overseeing data-gathering activities to maintain strict adherence to ethical principles. By employing this method, the study sought to remove any potential for coerced participation or power dynamics that could affect the outcome of the study.

3.1.3 Data collection

A combination of FGDs, observation schedules, individual learner reflections, and class activities was collected as data. FGDs were particularly valuable as they fostered a comfy group setting, encouraging participants to engage more openly and share their perspectives within the group. (du Plooy-Cilliers et al., 2014:175).

Denscombe (2010:196) states that observations provide direct evidence. However, Muthusamy (2015) describes observation as the researcher's act of attending a school or classroom to observe ongoing activities. These methods offered valuable insights into classroom dynamics. During lessons and classroom activities, the IWBs were used. Learner self-reflections, captured during FGDs, played a key role in assessing the effectiveness of IWBs.

The duration of the fieldwork spanned one month. The researchers did three action research cycles. After each cycle (see Appendix A), observations formed and the internal part of the reflection and analysis phase. Strict confidentiality protocols were followed with the data.

Access was limited to only the principal researcher and the supervising academic, ensuring thorough oversight and guidance.

The researcher developed a comprehensive Data Management Plan (DMP). The plan was developed to detail the protocols for handling and sharing data. The DMP specified the secure transfer of anonymised data between the researcher and supervisor, as well as the processes for data access and long-term data security.

An assent process was implemented to obtain informed consent from parents and guardians. The minors were provided with age-appropriate information sheets. The information on the sheets was explained in a suitable manner for the minors to fully comprehend the study's purpose and their role. Minors were invited to agree to participate voluntarily, free from any pressure or coercion, thereby reaffirming their understanding and willingness to engage in the research.

All parties-minors, parents and guardians were fully informed and agreed with the terms of participation. The consent forms and participation information sheets clearly outline the supervising academic's access to data

The data were meticulously documented to ensure accuracy and transparency. An amendment detailing these updates, including the newly implemented assent process for minors, was added to the original research proposal. The researcher submitted the amendment to the Ethics Committee for approval.

For this study, an unstructured observation method was employed with Grade 6 learners, enabling the researcher to actively participate during the observation process. This approach provided deeper insights into classroom dynamics and interactions. As highlighted by van Wyk (2019), several key factors contribute to ensuring accurate findings that can be effectively triangulated, including:

(i) The researcher(s) become immersed in the participants' educational context.
(ii) Events are depicted within the actual real-life context where they occur.
(iii) Participants may display behaviour they would typically try to cover.
(iv) Discrepancies between what was observed during practice teaching and what was said in the interview(s) may be discovered.
(v) Being actively involved in the participants' daily lives allows the researcher to observe and report their everyday behaviour. This will furthermore allow the researcher to reflect more accurately on the findings.

The researcher acquired a deeper understanding of how participants interacted with and engaged with digital tools through observations conducted during the sessions when the sampled participants used technology as a pedagogical tool. The researcher led the sessions and observed the learners as they engaged in active learning using digital tools in the classroom, which enhanced the process. This allowed the researcher to thoroughly understand the participants' use of technology in the classroom.

FGDs, as described by Sim and Waterfield (2019:3004), have their origins in group interviews and are recognised as a valuable research strategy. According to these experts, FGDs facilitate dynamic discussions and generate diverse perspectives. Additionally, du Plooy-Cilliers et al. (2014:175) highlight that FGDs can help participants feel more comfortable and at ease when engaging in a group setting, encouraging open and collaborative dialogue.

During the FGDs, a set of questions was asked (see Appendix A) with the aim and purpose of enhancing learner participation using the IWB in large classes in a primary school. The study also focused on the sub-aims of involving learner participation in a large class and using the IWB in a large class to actively engage the learners.

The FGDs consisted of six participants. This small number was chosen to ensure that everyone had an equal opportunity to contribute to the discussion. The researcher posed the questions during the FGD, allowed the principal to take part in the interview, and was careful to avoid any bias that could make participants feel inferior to or intimidated by the other group members. Each group member addressed the entire audience, encouraging participation, guiding the discussion in the right direction, and, when necessary, providing clarification on the topic at hand. To facilitate data analysis, the discussions were recorded, and transcriptions were produced later.

3.1.4 Data analysis

Qualitative data analysis follows an inductive approach, moving from specific, detailed results to broader general categories. Data from the transcripts were coded and grouped into themes, which were then reorganised into overarching categories or a general theory. Through this process, themes were identified and refined, ultimately evolving into well-defined categories that capture the essence of the data.

Thematic analysis was used to categorise the data into themes that directly aligned with the research questions and the TPACK framework. All themes contributing to learner engagement were examined (Braun & Clarke, 2006). The ‘increased interaction through multimedia tools’

and ‘challenges in adapting to new technology’ were linked to TK and PK. This demonstrated how the IWB supported or hindered engagement in the classroom.

To address any concerns about achieving data saturation with six participants, it is important to explain the study's strategic approach towards in-depth qualitative analysis. Learners’ perspectives and experiences on the IWBs were the aim of the study. The amount of the sample size is not as important as the amount and quality of data collected from each participant in response to a narrowly focused research topic in a highly particular setting. The study utilised several data-gathering techniques, such as in-depth FGDs, individual reflections, and direct observations, to ensure data saturation among the six participants. These techniques were selected based on their deep and complex insights into how learners interact with IWBs.

Due to the qualitative nature of the study, only a limited number of experiences could be thoroughly explored to provide a comprehensive understanding of the phenomenon. Additionally, the data analysis process was iterative, meaning that new themes and patterns were frequently assessed for their comprehensiveness and depth. This iterative process played an active role which evaluating the point of data saturation while ensuring that the analysis remains receptive to fresh ideas. What is data saturation? Well, data saturation is considered achieved when themes recur and emerge consistently, and no new or relevant information arises from the data. This study ensured comprehensive insights from the selected participants by utilising a rich qualitative data set and applying a rigorous analytical framework. This approach effectively addresses the concept of data saturation without requiring an increase in sample size.

An iterative process was followed. The themes were continually revisited and refined as new data emerged from each action research cycle. Nowell, Norris, White & Moules (2017) state that this iterative approach allowed for the gradual development of a comprehensive understanding of how IWBs impacted learner engagement.

This study implemented procedures to eliminate unethical biases and ensure a fair and impartial analysis of the research findings. A methodical and clear analytical approach was employed, involving the coding of data without knowledge of the participants' identities to reduce potential biases from the researchers. Triangulation was utilised by cross-referencing data from several sources, such as FGDs, observation schedules, and individual learner reflections, to confirm the results and minimise bias.

A reflective approach was adopted by the researcher. To enhance protection against bias the researcher organised peer debriefing sessions. The analysis process was assisted by independent researchers. This technique aimed to maintain the integrity of the data analysis process.

According to du Plooy–Cilliers et al. (2014:175), qualitative studies focus on conclusions drawn from unprocessed data. The researcher employed various analytical approaches to triangulate the data. The FGDs and participant observations provided opportunities to enhance the objectives and improve the accuracy of the findings and inferences.

During the analysis process, the data were organised into categories and subcategories. By making use of this approach, the researcher was able to achieve valuable and meaningful study findings. Coding was used to organise the data into these categories. The research sub–questions were mapped from each theme that emerged from the analysis.
All the strengths and shortcomings of CK, PK and TK were able to triangulate through the analysis phase.

3.1.5 Qualitative data analysis

Williams and Moser (2019) describe qualitative data analysis as encompassing various approaches and techniques for interpretative data gathering. According to van Wyk (2019), data analysis serves three primary purposes: (i) to describe the phenomenon under study, (ii) to interpret and give meaning to the variations within the phenomenon, and (iii) to develop a potential theory based on the findings.

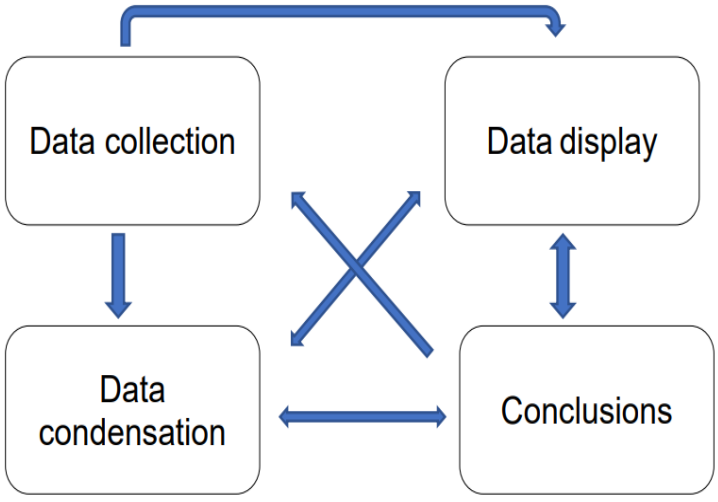

Figure 5: Qualitative data analysis

Source: Miles, Huberman & Saldana (2014)

As discussed in section 3.1.3, the data collection strategies for this study included FGDS and participant observations. The data gathered were coded.

This study utilised open, axial, selective, and thematic coding. According to Bezuidenhout and Cronje (2014), the open coding process involves the researcher reading through the transcribed focus group interviews and observation notes, reviewing all the text to develop themes and grouping them into categories. Following this, the findings from open coding were reanalysed using axial coding to identify the core themes of the study. The researcher then explored the relationships and connections between the identified concepts and categories.

3.3 Trustworthiness of the research

du Plooy-Cilliers et al. (2014) state that trustworthiness is a key criterion for evaluating the validity of research findings in qualitative studies. There are four components in which trustworthiness is grounded through transferability, credibility, dependability and confirmability. To ensure credibility in this study, triangulation was employed to validate the data provided by participants during observations and FGDs, confirming its accuracy and reliability.

A purposeful sampling method was employed in the study. To address potential challenges, the researcher consistently referenced the theoretical framework of the investigation, emphasising how the TPACK domains guided both data collection and analysis. Given the researcher's active involvement in the study, which could increase the risk of bias, triangulation was used to mitigate this risk and promote confirmability. The primary goal of the interview questions was to gain deeper insights into the participants, their perceptions of the IWB, and whether the IWB facilitated more effective engagement with the teacher.

3.4 The researcher's role

This study aimed to address the main research question and its sub-questions. The objective was to convey the findings honestly, as required by the research procedure. To accomplish these goals, the researcher had to be open and transparent with all the participants in the study.

The researcher was internally involved and a part of the phenomenon under study. Using action research, the researcher generated information and followed a process to enhance her pedagogical practice. It was essential for the researcher to establish and maintain a safe

environment throughout the research endeavour. The principal was invited to the interviews as a "neutral" party to be present in the interview room in addition to the participant observation.

To ensure triangulation, the researcher also managed the data analysis process and the verification of the information obtained through a range of data-gathering approaches.

3.5 Ethical considerations

Critical human factors can permanently affect the ethical implications of the research and the fulfilment of promises made. Before the research could commence, permission was sought from the Faculty of Health and Wellness Research Ethics Committee at CPUT. Following this, the necessary permissions from the WCED were obtained.

The required consent forms for this study's research participants were presented to all of them. Since all participants were minors, the consent form required the signature of each participant's parent. This was necessary to protect the participants' rights and security. The scope of the research project was explained to both the participants and their parents before they signed the consent form. The communiqué also provided reassuring information and outlined the specifics relating to confidentiality and anonymity. Participants' names were not recorded during the study procedure; instead, each participant was assigned a pseudonym, such as P1, P2, P3, and so on. Although the researcher can match each participant's response, this information will remain confidential and will not be shared with anyone else.

The consent forms clearly outlined the participants' right to withdraw from the study at any time if they chose to do so. All comments, volunteered information, and opinions shared during FGDs and unstructured observations were kept strictly confidential, ensuring the participants' privacy and protection from any potential victimisation. Additionally, secure online data storage facilities safeguarded participants' responses and private information. Participants were also assured that their physical comfort would be prioritised throughout the study, and no questions unrelated to the research objectives or deemed unusual would be asked.

3.6 Benefit vs risk analysis

The study clearly outlined the potential risks to participants, such as feelings of anxiety during the FGDs or discomfort with using unfamiliar technology. While the use of IWBs was hypothesised to enhance learner engagement based on previous research, the study acknowledged that this assumption requires empirical validation.

Increased engagement and improved learning outcomes were potential benefits that were communicated to the participants. The well-being of the participant was a priority. Measures were in place to monitor and address any adverse effects during the study.

The utmost respect for participants was shown throughout all the research activities. The study's findings were communicated to the participants and keeping them informed.

A clear protocol was established in the end. Upon concluding the study, a summary of findings was prepared for participants. A Session was organised with the school administration, the learners and their guardians to present the findings.

If ever a decision was made whereby individual participants would not be provided with feedback, this decision was based on specific and justified reasoning, which included the broader dissemination of results through academic channels that may not directly or immediately affect the participants' educational experience. All participants were fully informed about the nature of their participation and the use of the information they provided.

Strict risk management protocols were implemented to ensure the protection of participants. These measures were robust and guaranteed data privacy and security, which included encrypted data transmission, participant information would be anonymous, and secure data storage facilities for all information. An open communication was fostered throughout the study with continuous support for the participants. The approach aimed to be a haven for all participants, enhancing the credibility and integrity of the study and promoting a supportive and responsive research environment.

To address potential adverse reactions among participants and to ensure access to the school's certified mental health professional, a structured referral system was established. A mechanism was designed to manage any emotional or psychological stress that might arise during the study.

3.7 Summary of the chapter

The methodology and research design are in-depth described in this chapter. Ethical considerations and protocol were carefully examined. Definitions of both participant and researcher roles were clearly explained. In Chapter 4, the findings from the study instruments used for the data are presented and analysed.

CHAPTER 4: FINDINGS OF THE STUDY

4.1 Introduction

This chapter presents the research findings derived from data analysis conducted through FGDs and participant observations of a sample of Grade 6 learners at a primary school in Paarl. The study's primary objective was to enhance learner engagement in large primary school classes through the use of interactive digital tools on the IWB. To achieve this, the research focused on two sub-goals: increasing learner participation in large classes and actively involving learners through the use of the IWB.

This chapter addresses the research question and sub-questions in a clear and accessible manner. The primary research question explored how to foster learner participation in large classrooms using the IWB. The sub-questions included:

a) What IWB tools (activities) can be used to improve engagement?

b) What strategies can be used to improve engagement in large classes?

c) What are the Grade 6 learners' perceptions of the IWB?

The TPACK theoretical framework guided the process of addressing the research and sub-questions. During the coding process, the researcher observed that the boundaries between different types of coding, as noted by Corbin and Strauss (1990), often appeared artificial and tended to blur, requiring a constant interplay between the three methods. The TPACK framework proved suitable for this study as it ensured that all its components were integrated into the interview questions. The researcher found that these components directly influenced the teaching and learning process with IWBs, providing valuable insights into their impact on classroom dynamics.

4.2 Cycle 1

During the first action research cycle, the learners demonstrated minimal interest during the introduction, with only two learners actively participating. However, a noticeable shift in enthusiasm and excitement occurred after the introduction when multimedia tools and the IWB were incorporated into the lesson. Approximately 60% of the class engaged when the IWB and Plicker cards were used.

Despite this improvement, several technological challenges emerged, including load shedding, slow Wi-Fi or resource loading, intercom disruptions, and confusion regarding the use of Plicker cards. The load-shedding and subsequent power supply interruptions negatively impacted lesson planning, as lessons could not proceed as scheduled due to the load-shedding schedule in Paarl. These disruptions affected the continuity of the lessons and

caused significant frustration among learners. One learner expressed their frustration, saying, "*I hate the technical issues about the IWB and the load-shedding*", a sentiment that was visibly shared by the rest of the class, as they nodded in agreement.
Due to the load shedding and internet connectivity provided by the Western Cape Education Department system, the effectiveness of lessons was compromised. The delays in the video impacted the lessons negatively. These issues cause much frustration for the learners, with some losing interest during the lesson.

The learners were introduced to Plickers for the first time during the weather activity. The use of the Plickers cards causes confusion among the learners at first. The use of the Plickers cards proved to be a significant issue. One learner commented, "*Mam, the symbol on the card looked like packman*", while another remarked, *“I don’t know and understand how the cards worked*”. This lack of understanding led to limited participation, and the explanation process had to be repeated.

However, once the learners grasped and understood how to use the Plickers cards, their enthusiasm grew. When their names appeared on the IWB, they became particularly excited. One learner made a statement, “*This is so cool. It is almost like magic*". Their curiosity and interest were evident as they eagerly asked countless questions, reflecting their desire for knowledge and understanding. Two learners expressed their enjoyment, with one saying, *"The class was more relaxing. I love ICT and Plickers. I could connect more. Therefore, I participated more than usual. It was so much fun*".

The learners' enthusiasm and interest in the activity, evident from their verbal and nonverbal responses, highlighted a strong potential for learning and engagement. Unfortunately, this potential was not fully realised due to various disruptions. The activity on the IWB could not be completed, with the class managing to answer only five out of the ten questions.

A significant increase in learner participation was observed after cycle one. However, some learners still refrained from engaging in the lesson. Additionally, several challenges remained outside my control, such as power outages, school intercom disruptions, and unreliable Wi-Fi. The learners and I collaboratively identified these deficiencies and worked to mitigate them as much as possible before commencing Cycle 2.

4.3 Cycle 2

In Cycle 2, I observed that more learners were positive and emotionally invested in their learning. This eagerness was complemented by their inquiry-based approach, as they posed numerous questions reflecting a desire for deeper understanding and engagement with the subject matter. In cycle two, the learners were now more familiar with Plickers and how to use the card. This allowed them to be more at ease, and they interacted more and asked questions more frequently. One learner remarked, "*I understand the work better because I can see pictures on the board, so I am more comfortable asking questions".*

A clear correlation emerged between the choice of teaching tools and learner participation. Specifically, learner engagement increased when the whiteboard was utilised. The learners expressed a strong preference for multimedia resources, such as videos and images, showing great enthusiasm for the integration of digital tools into the lesson. However, I noticed a significant drop in participation for about five minutes when I switched to traditional methods, using the textbook and green board. One learner commented, "*The textbook is really boring*", while some nodded in agreement and others simply stared. When the lesson resumed with the IWB, most learners regained their interest and engagement.

The second cycle demonstrated significant improvement, with enhanced learner participation and engagement. The learners showed increased involvement in classroom discussions, displaying heightened enthusiasm and motivation. Their responses to activities improved markedly, positively influencing their academic performance. However, despite these advancements and improvements in addressing technological challenges, fully engaging all 41 learners in classroom discussions remained a challenge.

4.4 Cycle 3

As I prepared for Cycle 3, I took a proactive approach by selecting the topic of the export and import of goods in South Africa and the world. I anticipated that this subject would not only spark engagement but also address common misconceptions among my learners.

To introduce the topic, I used a carefully crafted video on the IWB to guide learners through the key concepts and theories related to exporting and importing goods. All forty-one learners enjoyed the video with its accompanying audio. After the video, many asked questions about the content, and even those who were initially unsure felt comfortable raising their hands and engaging in the discussion. Some learners began answering their peers' questions. Two learners commented, "*Playing a video or audio clip during the lesson makes me feel at ease. I understand the work better, so then I am more comfortable participating in class*". Another added, "*I am a visual learner, so I will only contribute to the class when I see pictures or videos*

in the classroom". My goal with showing the video was to deepen their understanding of the topic while fostering a safe and supportive environment for discussion.

The post-video discussion revealed enhanced learner participation. One learner admitted, "*I am shy. The classes are very big. I do not like to participate every day. I sometimes do not understand when the teacher uses the handbook, but when she teaches with the IWB, I am more comfortable giving my input*". This shift indicated that some learners had gained self-confidence and were more willing to express their opinions and answers.

Interestingly, learners who had been hesitant in Cycle 1 to use the IWB with the smart pen became noticeably bolder and more confident in Cycle 3. When it was time to use the Plicker cards for an activity, excitement filled the room. One learner exclaimed, "*'I love Plickers, this is so cool!*" Others expressed appreciation for the use of my cell phone during the lesson, with some calling it "*nice*" and recognising its relevance to the activity. Although participation had been somewhat limited in Cycle 1, and some learners were still shy, there was a marked improvement by Cycle 3. Learners began engaging in debates, sharing their opinions, and actively contributing to discussions.

After completing the three cycles, I observed a significant improvement in classroom participation. The action research cycles highlighted the effectiveness of IWBs in enhancing learner engagement and academic achievement within a large classroom setting. Through iterative refinement over the three cycles, I witnessed notable increases in learner participation, motivation, and performance. These findings suggest that IWBs have the potential to transform teaching and learning, making it more engaging, interactive, and effective.

4.5 Focus group interview

4.5.1 Technological Knowledge (TK)

Question 2: What did you like and dislike about the IWB?

The learners shared their specific interactions with the IWB technology, highlighting their likes and dislikes, which provided valuable insights into how they engaged with technological tools. During the FGDs, participants were asked questions to identify their preferences and concerns regarding the IWB.

Their diverse responses revealed that the learners generally felt the IWB enhanced their engagement with the educator during lessons. The focus group participants reported the following:

> "*The IWB is a helpful tool for visual learning and understanding*" (P1).
>
> "*The screen is so big. It is bigger than the green board; I can see everything. I like the videos and pictures. Hmm, I liked everything about the IWB*" (P2).
>
> P3: "My favourite part about the IWB is the beautiful colouring pictures" (P3).
>
> "*I love the IWB because of all the tools. Playing Plickers on the IWB was the best lesson ever. I loved it!*" (P4).
>
> "*I loved Plickers. The gamification that the IWB allowed. My favourite part is when the teacher took out her phone. The IWB allowed all this. I understood the work better*" (P5).
>
> "*The IWB gives you access to everything on the internet. I liked it because the teachers can just search for images or videos related to our class topic, Mad about it*" (P6).

The responses indicate that the participants enjoyed using the IWB, showcasing how innovative technology can captivate and sustain learner attention. The learners' excitement and curiosity about the IWB and associated tools, such as Plicker cards, were evident during every lesson. During one observation, it was noted that "*the learners went crazy. Some thought using a cell phone in class is not allowed*". A feature that displayed the learners' names on the whiteboard particularly engaged them, with participation noticeably increasing when the teacher used various digital tools on the IWB.

These interactive tools encouraged active participation and engagement in a large classroom setting. Supporting this, Kirbas (2018:1040) asserts that technology can enhance learner engagement by offering interactive tools and more personalised learning experiences. Similarly, Beeland (2006) highlights that IWBs increase learner engagement and contribute to creating more learner-centred classrooms. These findings, supported by both quotes and research, underscore how innovative technology captivates and maintains learner attention, transforming the learning environment into an interactive and engaging experience.

4.6 Dislikes with the IWB

The focus group participants reported the following on their dislikes about the IWB:

> "*The screen is huge. I do not like the brightness in my eyes*" (P1).
>
> "The pen does not write where you want it to, even after calibrating the board" (P3).
>
> "*The blinds in the class do not block out the sun, so I find it difficult to see on the board*" (P2).
>
> "*I hate the technical issues about the smartboard and the load-shedding*" (P5).

Question 3: What is your perception of the IWB?

This question directly explored learners' perceptions of a specific technology used in education. Their responses revealed that all participants held positive perceptions of the IWB. The focus group participants shared the following:

> *"I love the IWB. Learning is much easier*" (P1).
>
> *“The lesson are more interesting and fun. I cannot live without it” (P2).*
>
> "*The IWB allowed me to participate and interact more in the classroom. I enjoy the content of the lessons much more*" (P3).
>
> *"When I see pictures and videos in the classroom I will then participate. I am a visual learner” (P5).*

When a lesson was presented with technology including multiple media, the researcher observed that the learners were more at ease participating. The data indicated that all the participants in this study had positive general perceptions of the IWB in the classroom.

4.7 Pedagogical Knowledge (PK)

Question 1: What elements make you want to engage more and less and less? During a lesson or in the classroom.

The researcher examined pedagogical strategies through the lens of learner engagement, exploring which teaching methods increase or decrease participation. Participants expressed a preference for technology-enhanced learning environments over traditional methods. They valued the dynamic and interactive elements that technology introduced to the classroom, as evidenced by their enthusiasm for activities involving the IWB.

The data highlighted the teacher's effective use of the IWB, including its integration into lesson plans and the creation of engaging learning experiences, showcasing strong pedagogical knowledge. The high level of learner participation – 95% of learners actively engaged during the lesson – and the adoption of integrative and inquiry-based teaching approaches demonstrated the successful application of pedagogical strategies in a large classroom setting. The focus group participants shared the following:

> "*I loved it when the teacher uses different learning styles and access to diverse and relevant educational resources*" (P1).
>
> *"Playing a video or audio clip during the lesson makes me feel at ease. I understand the work better, so then I am more comfortable participating in class*" (P2)
>
> "*Playing games to teach any subject is so cool. I am excited to participate because I love games"* (P4).
>
> "*Even though I want to engage, I am too shy. The class is very big, and I lack confidence*" (P5).

Findings revealed that lessons incorporating multimedia materials resulted in higher levels of learner participation. Learners were more engaged when the teacher utilised gamification and game-like features. In other words, the findings indicated that lessons taught using multimedia were more effective than those taught through traditional methods. Mayer (2002) explains that visual and auditory information is initially processed in short-term memory, which serves as the first stage of information processing. From there, sounds and images are transferred to the working memory for further processing

4.8 Technological Pedagogical Knowledge (TPK)

Question 4: Did you engage more when the teachers introduced the tool and IWB? How did you feel?

Question 4 focused on the method of technology introduction and its effect on learner engagement, reflecting pedagogical approaches. The focus group participants responded as follows:

> "*Yes, I engage more; I understand the work better. The teacher now walks between our tables while presenting the lesson*" (P1).
>
> "*It was exciting. I felt more comfortable, and I do not like lessons that do not have any pictures*" (P3).
>
> "*The class was more relaxing. I love ICT and Plickers. I could connect more. Therefore, I participated more than usual. It was so much fun*" (P4).
>
> "*I' am shy. The classes are very big. I do not like to participate every day. I sometimes do not understand when the teacher uses the handbook, but when she started to teach using the IWB, I became more comfortable giving my input*" (P6).

The data indicated that learners felt more at ease when the teacher used the IWB. Schindler, Burkholder, Morad, and Marsh (2017) note that whether technology is integrated during class time or after school hours, it provides learners with more opportunities to interact with instructors, collaborate with peers, and actively engage in the learning process. Additionally, Schindler et al. (2017) highlight that studies have shown digital games to be effective in enhancing learner engagement.

4.9 Content Knowledge (CK)

Responses to Question 5: Have you understood the work content better using the tool?

Learners expressed that using technological tools such as the IWB significantly aids their understanding of the subject matter, highlighting the positive impact of these tools on content delivery.

"*I understand the work better because of all the pictures, colours and videos*" (P1).

"*The lessons are more interesting, and the textbooks have information. I can now see videos, which help me to understand the work better*" (P2).

"*The text on the PowerPoint is less when showing on the board. So I understand much better*" (P3).

"*The lesson was about cities I have never been to, but the teacher only googled the place and showed us. It feels like I have been there. So now, I understand and can engage about how the place looks even though I have never been there personally. I like all these ICT tools because they allow me to participate in class*" (P5).

"*The work is no longer boring for me; I understand and doing an activity is now fun for me*" (P6).

The data from the participants indicate that ICT has enhanced their understanding of the content.

4.10 Pedagogical Content Knowledge (PCK)

Question 6: What would be the ideal class, number, classroom or lesson?

Describe what relates to PCK. This refers to invites descriptions of an optimal educational environment, often including integrated discussions of effective content delivery methods and pedagogical approaches. The participants responding the following:

"*More space and a better teacher-learner ratio*" (P1).

"*A clean and big class. A Class with a smartboard and tablets for all the learners will replace the textbooks. The textbooks are so heavy*" (P2).

"*A child-friendly, colourful class, when the teachers are always prepared and up to date with the technology*" (P3).

"*Fewer learners, an IWB, tablets and uncapped Wi-Fi*" (P4).

"*Not so many learners, A IWB and tablets. An air con would be cool, a passionate teacher. A class where everybody is just happy*" (P6).

The data revealed that three participants preferred smaller class sizes, while all six participants expressed a preference for a class incorporating ICT. The effective use of the IWB in a large classroom setting, which led to high levels of learner engagement and participation, reflects a seamless integration of technology, pedagogy, and CK.

4.11 Technological Pedagogical Content Knowledge (TPACK)

4.11.1 Overall feedback and observations from the interview cycles:

The detailed accounts of how technology, pedagogy, and content interact in real classroom scenarios – particularly regarding the integration of technology like IWBs with teaching methods and subject matter – provide a clear demonstration of TPACK in action. The data showed that using multimedia on the IWB in a large classroom significantly increased learner participation.

The findings revealed that learners preferred lessons incorporating interactive tools, expressing that such lessons moved away from traditional teaching methods. Learners emphasised the importance of educators adapting to modern teaching approaches, acknowledging that "the world is only a click away". The data confirmed that participants were more responsive and engaged during digital lessons, particularly when multimedia was used. As one participant remarked, "*I hear, I forget, but when I see the picture, I remember*".

The FGDs further highlighted that classroom participation improved dramatically, with engagement increasing by 100% when interactive tools were used.

4.12 Summary of the chapter

In summary, the data demonstrated that using the IWB significantly increased learner participation. The learners' responses reflect the various components of the TPACK framework, illustrating how the IWB was utilised not merely as a technological tool but as an integral part of a holistic educational strategy that seamlessly integrates TK, PK, and CK.

CHAPTER 5: CONCLUSIONS, INTERPRETATION, AND DISCUSSION

5.1 Introduction

The teacher-to-learner ratio in South African schools has increased from 1:40 in 2016 to 1:45 in recent years. This shift presented challenges for the researcher in an overcrowded classroom, where learners were reluctant to engage and participate during lessons. Since learner engagement is crucial for effective learning, teachers must explore innovative strategies to motivate and encourage participation in the classroom.

This study explored how learner participation in a large classroom can be addressed through the use of an IWB. Its primary aim was to enhance learner participation by integrating interactive digital tools on the IWB in large primary school classes. The study was further guided by the following sub-aims:

a) Involving learner participation in a large class.
b) Using the IWB in a large class to actively involve the learners.

This chapter provides an overview of the research to assess whether the study's objectives have been achieved. It summarises the key findings, reviews the chapters, and presents practical recommendations, limitations, and suggestions for further research. The data on how the IWB can enhance learner engagement in a large classroom are highlighted.

The structure of the chapter is as follows: This chapter begins with an introduction, setting the stage for a comprehensive overview of the study. A summary of the first three chapters is provided, revisiting the foundational aspects of the research to contextualise the findings. The chapter then transitions to a detailed summary of the findings, including an overview of the action research cycles and key insights related to the use of IWBs. The integration of these findings within the TPACK framework is explored, highlighting the interplay of CK, TK and PK.

A discussion follows, interpreting the findings and examining the impact of IWBs on teaching and learning. This section discusses the practical implications of the research, offering insights into how IWBs enhance learner engagement and contribute to educational practices.
Challenges and limitations encountered during the study are also addressed in this chapter. Practical implications are discussed, alongside recommendations for future research to expand on the study’s contributions. Lastly, the chapter provides a summary, encapsulating the key points discussed and tying them back to the study’s objectives and broader implications.

5.2 Overview of Chapter 1

Related to teaching in an overcrowded classroom, the researcher faced challenges such as learners who refused to participate during lessons. Learner engagement remains essential for effective learning, and teachers must find new ways to motivate and encourage participation in the classroom.

This study explored how the need for learner participation in a large classroom can be addressed using an IWB. It aimed to enhance learner participation through interactive digital tools integrated with the IWB in large classes at a primary school. The study was also guided by sub-aims:

a) Involving learner participation in a large class.

b) Using the IWB in a large class to actively involve the learners.

5.3 Overview of Chapter 2

Chapter 2 focused on the literature findings that informed the theoretical framework for teaching and learning, particularly with the application of IWBs. Modern teaching literature increasingly emphasises the integration of educational technology into daily practices, reflecting its growing importance in contemporary education. The South African government has also highlighted the use of educational technology for teaching and learning as a high priority. Furthermore, numerous studies, such as those by Brouse et al. (2011) and Garrett (2009), have demonstrated the benefits of incorporating technology into educational settings (Brouse et al., 2011; Garrett, 2009).

As stated by Tefo and Pitsoane (2023), the TPACK framework explains how technology, pedagogy, and content interact to enable teachers to develop context-specific and appropriate teaching and learning strategies (Koehler & Mishra, 2009).

5.4 Overview of Chapter 3

Chapter 3 outlined the research methodology employed in this study, framed within an interpretive paradigm. Littlejohn and Foss (2009) describe the interpretive approach as one that seeks to understand the world through the direct experience of phenomena. Similarly, du Plooy-Cilliers et al. (2014:173) emphasise that interpretivism aims to comprehend and interpret meaningful experiences and social actions.

A qualitative research approach was adopted for this study. According to du Plooy-Cilliers et al. (2014), qualitative research focuses on uncovering underlying qualities and is less concerned with sample size, prioritising in-depth insights into participants' experiences. Ugwu and Eze (2023:20) concur, highlighting that qualitative research emphasises understanding

ideas and experiences, particularly in exploring how participants perceive and feel about pedagogical practices. Denscombe (2010:283) further explains that qualitative research often employs strategies such as case studies, grounded theory, ethnography, and phenomenology, using tools like interviews, documents, and observation.

To gain a comprehensive understanding of diverse realities, this study used focus groups and lesson observations across three research cycles as data collection methods. These methods were meticulously planned to provide detailed insights into the effectiveness of IWBs in a specific educational context. By embracing the unique characteristics of the sample, the study offers valuable insights for educators, policymakers, and future researchers.

Slavin and Smith (2009) state that smaller sample sizes often yield more profound effects compared to larger studies. Similarly, Koehler and Mishra (2009) successfully utilised small samples to explore teacher perspectives on technology integration. Stake (2005) argues that small sample sizes enhance the depth of data, a perspective supported by Creswell (2014), who states that adopting a limited sample size prioritises ecological validity and contextual understanding over extensive generalisability, aligning with the conventions of qualitative research.

The study made use of action research, which emphasises the active involvement of teachers in the research process. As stated by Denscombe (2010), this concept originates from the works of pedagogical pioneers such as John Dewey and Kurt Lewin. The focus of action research is on teachers, positioning them not merely as subjects but as active participants in the process, providing ongoing insights to improve educational practices.

Action research is described by Denscombe (2010:1260) as a process of collecting data to enhance relevant practices. This methodology provided dynamic, iterative insights that informed teaching practices and improved learner engagement. The iterative cycles of action research added credibility to the study's outcomes, ensuring that the research remained responsive to emerging challenges. Denscombe (2010) also highlights the importance of teachers being actively involved in the learning process, reinforcing the collaborative and reflective nature of this approach.

The ethical importance and considerations, reliability and validity were carefully addressed throughout the study. The processes of data gathering, transcription, and analysis were meticulously documented. An amendment detailing updates, including the newly incorporated assent process for minors, was added to the original research proposal and submitted to the

relevant ethics committee for approval. This demonstrated a clear commitment to transparency and ethical compliance in the research process.

According to McMillan and Schumacher (2010), inductive analysis involves classifying, analysing, and interpreting data to understand a specific phenomenon, such as how learners interact with the IWB in the classroom.

5.5 Summary of findings

5.5.1 Overview of the action research cycles

It was intriguing to observe that the learners in Cycle 1 desired to stay out of the spotlight and did not use the smart pen to accomplish anything on the IWB, as they were unfamiliar with working on it. Cycle 1's involvement was limited, and some learners were still not open to participation, but things improved in Cycles 2 and 3. The participants became more engaged in discussions and felt at ease expressing their ideas to me. The researcher observed that the learners' initial resistance was overcome as they became more comfortable in class and familiar with the IWB and Plickers cards.

After completing the three cycles, the researcher could verify, or at least conclude, a significant increase in participants' classroom engagement. The action research cycles demonstrated the effectiveness of IWBs in raising learners' engagement and academic achievement in a large classroom setting.

Following Cycle 1, the researcher discovered that the use of the IWB significantly increased participants' participation. However, some participants still needed to engage more with the material. Additionally, there were various gaps the researcher wished to control more effectively, such as the school's Wi-Fi, power outages, and intercom disruptions.

In Cycle 2, the researcher noted considerable improvement in participants' participation and engagement. The learners were braver and more self-assured when taking the lead and using the smart pen to perform tasks on the IWB. The participants displayed greater engagement in class discussions, along with increased motivation and excitement. Furthermore, they showed significant improvement in their responses to exercises, which positively impacted their academic achievement.

The researcher observed a significant increase in participants' classroom engagement after completing the three cycles. The action research cycles demonstrated the effectiveness of IWBs in enhancing learners' engagement and academic achievement in a large classroom setting.

After three iterative refinement cycles, the researcher noted a remarkable improvement in learner engagement, motivation, and academic achievement. The results suggest that IWBs have the potential to revolutionise education by increasing its effectiveness, interactivity, and engagement.

Despite encountering challenges during the lessons, such as load-shedding, poor Wi-Fi, and disruptions from the school intercom, the researcher had solutions, such as offline versions of IWB tools, in place. However, while the learners possessed ICT skills, many needed to learn how to use the Plickers cards properly. Some were even sceptical about coming to the board at the beginning of Cycle 1.

5.5.2 Key findings related to IWBs

The data showed that the IWB's impact on teaching practices enabled the researcher to deliver more interactive and engaging lessons. The IWB allowed the teacher to cater to a diverse, large group of learners.

Not only did the IWB positively impact teaching practices, but there was also an increase in learner engagement and motivation. The findings of this study align with and contribute to the existing body of research on IWB use in educational settings. Obaid (2022) conducted a study on the effect of the IWB in an English class with a larger sample group, and the data also showed the positive impact the IWB had on learner engagement in the classroom. Similarly, Issa (2020) completed his master's on the IWB and engagement, and the data also indicated that the IWB indeed improved learner participation in the classroom.

Studies have shown that the IWB has a generally positive impact on learners. The use of the IWB in classroom activities has increased learner engagement. Learners now actively participate in class discussions and share their stories, notes, Toscu (2013). In agreement, Tertemiz, Kalyon, Can, Duzgun and Serkan (2015) claim that the IWB encourages learner participation and interaction as they debate and select the most appropriate solutions.

Moreover, Tertemiz et al. (2015) stated that the IWB enhances participation in class discussions and enables learners to share their stories. Toscu (2013) conducted a similar study and found that the IWB encourages learner participation and interaction as they debate and select the best solutions.

Learners who were previously disengaged are now more motivated to participate. They enjoyed working on the IWB and found it fun and interactive. The data also showed that the

IWB facilitated active participation and discussion not only with the teachers but also with their peers.

Using the IWB also increased academic performance in geography. The learners' test marks improved, and they demonstrated a better understanding and retention of concepts that benefited from visual and interactive content.

5.6 Integration with TPACK framework

This study's findings on IWB are grounded in the TPACK framework (Koehler & Mishra, 2009). The interconnectedness of the framework was evident. During the study, the researcher utilised TK from the IWB to deliver engaging lessons, making increased use of technology within the classroom. She prepared her lessons daily using PowerPoint and included videos and pictures to enhance learners' understanding of the concepts (TK). The pictures were selected to be familiar to the learners. The PowerPoint lesson incorporated various videos and images, and the researcher conducted activities using Plickers. All lessons, videos, PowerPoints, and interactive games were displayed on the IWBs. The researcher applied PK to facilitate a more learner-centred environment, encourage participation, and manage the classroom (PL + CK). The Plickers activity and questions were also structured in this way, incorporating pictures and videos when questions were posed. Learners responded to the questions using a card game, which resulted in high levels of participation.

The researcher integrated CK to present a subject aligned with the learning objectives and outcomes (TK + PK + CK). CK was enhanced through the use of multimedia content during the lessons, catering to different learning styles and supporting PK. Additionally, many activities were subject-based, reflecting the integration of Pedagogical Content Knowledge (PCK).

5.7 Discussion

5.7.1 Interpreting the findings

In Cycle 1, the researcher found that the learners participated much more in class when the IWB was used. The responses indicated that the participants liked the IWB. Engagement increased by 100% when the teachers utilised the various digital tools available on the IWB. Such interactive tools encouraged active participation and engagement among learners in a large classroom setting. Research supports this; Kirbas (2018:1040) states that technology can enhance learner engagement by providing interactive learning tools and more personalised learning experiences. Kirbas (2018) further concurred that learner engagement in the classroom is heightened with the IWB. These findings illustrate how innovative technology captivates and maintains learner attention.

In Cycle 2, the researcher observed that more learners were positive and emotionally invested in their learning. This eagerness was further complemented by their inquiry-based approach, as they posed numerous questions that demonstrated a desire for a deeper understanding and engagement with the subject matter. They seemed more prepared and at ease, as they understood how to use the Plicker cards during the activity. The learners interacted significantly more and asked questions more frequently.

A notable correlation emerged between the choice of teaching tools and learner participation. Specifically, learner engagement increased, and participation rose when the researcher utilised the whiteboard. The learners strongly advocated for multimedia resources, such as videos and images, and showed great enthusiasm for all the integrated digital tools within the lesson.

After completing the three cycles, the researcher noticed a substantial improvement in learners' participation in the classroom. The action research cycles demonstrated the effectiveness of IWBs in enhancing learner engagement and academic achievement in a large classroom setting. The researcher observed that learners wanted to participate more actively. When lessons were presented, the learners raised their hands more freely. Additionally, they participated with ease and confidence, not only with the educator but also in sharing with one another. Since the IWBs were used, the learners understood the content better and enjoyed coming forward to work on the board. This was particularly popular among the girls, as more of them wanted to take part. The researcher found that the learners enjoyed watching videos during the lesson and felt comfortable sharing their opinions in the classroom. Through three cycles of iterative refinement, the researcher observed a significant increase in learner participation, motivation, and academic performance. Each cycle showed continuous improvement and demonstrated the potential of the IWB.

The findings suggested that IWBs have many contributing factors that enhance learning, transforming teaching to make it more engaging, fun, interactive, and effective. In Cycle 1, the introduction of the IWB led to a 30% increase in learner engagement. In Cycle 2, the refinement of IWB integration resulted in a further 20% increase, and in Cycle 3, IWB activities and participation led to an additional 40% increase in learner participation.
The data indicated that learners felt more at ease when the teacher used the IWB. Mo (2011) and Schindler et al. (2017) state that whether technology is integrated during class time or after school hours, it provides an opportunity for learners to participate and interact with their teachers and peers; face-to-face engagement positively impacts the learning process.

Schindler et al. (2017) further assert that studies have demonstrated the effectiveness of digital games in enhancing learner engagement.

5.8 Impact of IWBs on teaching and learning

The data in the study have shown that the use of the IWB had a positive effect on the various teaching strategies employed by teachers. The IWB enabled educators to utilise multimedia resources, such as images and videos in PowerPoint, to support visual learning. During the observation, the teacher used Plickers, which allowed for immediate feedback based on the learners' responses. This had a positive impact, as the teacher could quickly identify which questions the learners did not understand. The IWB benefited both the teacher and the learners, making the lessons more interactive, engaging, enjoyable, and exciting, which had an overall positive effect on everyone involved.

5.9 Challenges and limitations

The challenges the researcher encountered during the study were technical issues, such as connectivity problems, which disrupted the lessons. During the data process, the town experienced a lot of load-shedding, which had a negative impact on the roster. Classes had to be adjusted due to the Eskom load-shedding schedule.

The study was restricted to a specific period, which may not capture the long-term effects of IWBs in the classroom. It focused on the use of IWBs in a primary school setting, and the findings may not be applicable to teachers facing similar issues in high school or other educational environments. Additionally, the study had a relatively small sample size of nine learners, which may restrict the generalisability of the findings. While the results are valuable for understanding learner engagement in the context studied, they may not be generalisable to larger populations.

5.10 Implications for practice

The TPACK theoretical framework needs to be familiarised among teachers. Teachers need to gain TPACK knowledge. Additionally, teachers should ensure that IWB activities align with the curriculum and content standards.

Issues such as WI-FI outages and load shedding are common issues teachers encounter.
School leaders should provide professional development and offer training sessions to enhance teachers' TPACK knowledge. The school must foster an ethos of sharing best practices and cultivating a supportive environment.

Funding for the purchase of IWBs should be allocated to schools. Professional development should occur quarterly to equip teachers with knowledge of the TPACK framework.

5.11 Recommendations for future research

Based on the insights derived from this research, the following recommendations are made for future research:

- Explore the effectiveness of IWBs in teaching and learning within smaller class settings.
- Compare the impact of IWBs on learner participation across different age groups and subjects.
- Investigate the influence of technical issues (e.g., Wi-Fi connectivity) on IWB effectiveness and learner engagement.
- Examine the impact of IWBs on teacher-learner relationships and classroom dynamics.
- Develop professional development programs for teachers, in collaboration with policymakers and educational institutions, to ensure teachers are fully equipped to use IWBs effectively.
- Investigate how external factors influence learners' readiness to engage with technology such as IWBs.
- Examine the impact of extrinsic factors, such as socio-economic background or prior exposure to technology, on learner engagement with IWBs.
- Replicate this study – focusing on the use of IWBs to enhance learner engagement in large classrooms – in Western Cape secondary schools.

5.12 Summary of the chapter

This study aimed to research and enhance learner participation in a large class at a primary school in the Western Cape through the IWB. Additionally, it sought to give learners a voice and create a more learner-centred classroom. The primary objective was to empower learners to take ownership of their teaching and learning, fostering a classroom environment where they can participate freely during any lesson. Education is a two-way conversation between individuals. Therefore, this study was conducted to amplify the voice of learners in the classroom, enhancing their participation so that they can engage freely not only with the educator but also with their peers.

The TPACK framework facilitated the research. The study discussed its limitations and offered recommendations. Based on the findings, the IWB positively impacts learner participation. This study provides valuable, nuanced insights into learner engagement and IWB use, which larger studies may not always capture. The richness of qualitative data often yields detailed, personalised accounts that are crucial for understanding the complexities of technology in education (Goodhue, Lewis & Thompson, 2012:981). The results indicated that learners

participated more actively during lessons. Furthermore, the findings demonstrated that the IWB is a teaching tool that increases learner participation and engagement, leading to better results. The conclusions of this study align with and contribute to the existing body of research on IWB use in educational settings.

Today's learners are expected to be ICT-savvy, preferring the latest advancements to keep pace with the world of education. Their experiences with using the IWB in certain subjects can be more motivating, as they often find traditional textbooks dull. The findings of this research have the potential to influence educational policies and classroom practices, enhancing teaching and learning through the true power of the IWB.

REFERENCES

Al-Faki, I.M. & Khamis, A.H.A. 2014. Difficulties facing teachers in using interactive whiteboards in their classes. *American International Journal of Social Science*, 3(2):136-158.

Alharahsheh, H. & Pius, A. 2019. A review of key paradigms: Positivism vs interpretivism. *Global Academic Journal of Humanities and Social Sciences*, 2(3):39-43.

Axelson, R.D. & Flick, A. 2010. Defining student engagement. *Change: The Magazine of Higher Learning*, 43(1):38-43.

Beeland, W.D. 2006. Student engagement, visual learning and technology: Can interactive whiteboards help? *Proceedings of the Annual Conference of the Association of Information Technology for Teaching Education*, 1-7.

Bezuidenhout, R.-M. & Cronje, F. 2014. Qualitative data analysis. In du Plooy-Cilliers, F., Davis, C. & Bezuidenhout, R. (eds). *Research Matters*. Lansdowne: Juta: 228-250.

Blignaut, S., Hinostroza, J.E., Els, C.J. & Brun, M. 2010. ICT in education policy and practice in developing countries: South Africa and Chile compared through SITES 2006. *Computers & Education*, 55(4):1552-1563.

Bolliger, D. & Martin, F. 2018. Instructor and student perceptions of online student engagement strategies. *Distance Education*, 39(4):584.

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

Brouse, C., Basch, C. & Chow, T., 2011. Use and efficiency of various technological methods in the different aspects of teaching and learning a foreign language at 16 universities in New York. *Journal of the Research Center for Educational Technology*, 7(1):1-117.

Bundick, M.J., Quaglia, R.J., Corso, M.J. & Haywood, D.E. 2014. Promoting student engagement in the classroom. *Teachers College Record*, 116(1):50-61.

Burden, R., 2002. How can we best help children to become effective thinkers and learners? In Burden R. & Williams M. (eds). *Thinking through the curriculum*. Milton Park: Routledge: 1-27.

Charland, P., Talbot, J. & Léger, P.M. 2021. *Impact of video engagement on learning outcomes*. Brain Sciences.

Chigona, A. & Chigona, W. 2010. An investigation of factors affecting the use of ICT for teaching in the Western Cape schools. *ECIS 2010 Proceedings*, 61.

Chng, L. & Gurvitch, R. 2018. Using Plickers as an assessment tool in health and physical education settings. *Journal of Physical Education, Recreation & Dance*, 89(2):19-25.

Corbin, J.M. & Strauss, A. 1990. Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, 13:3-21.

Corso, M., Joseph, M., Quaglia, R. & Haywood, D. 2014. Promoting student engagement in the classroom. *Teachers College Record*, 116(1):50-61.

Creswell, J.W. 2014. *Research design: Qualitative, quantitative and mixed methods approaches*. 4th ed. Thousand Oaks: Sage.

Creswell, J.W. & Poth, C.N. 2018. *Qualitative inquiry and research design: Choosing among five approaches*. 4th ed. Thousand Oaks: Sage.

Damick, J. 2015. Implementing technology in an algebra classroom. Unpublished master's thesis, State University of New York, New York.

Denscombe, M. 2010. *The good research guide*. Glasgow: Bell and Bain.

du Plooy-Cilliers, F., Davis, C. & Bezuidenhout, R. 2014. Research matters. In du Plooy-Cilliers, F., Davis C. & Bezuidenhout, R. (eds). *Research matters*. Cape Town: Juta: 173-195.

Elmahdi, I., Al-Hattami, A. & Fawzi, H. 2018. Using technology for formative assessment to improve students' learning. *Turkish Online Journal of Educational Technology*, 17(2):182-188.

Erdener, K. & Kandemir, M. 2019. Investigation of the reasons for students' attitudes towards the interactive whiteboard use in mathematics classrooms. *International Journal of Research in Education and Science*, 5(1):331-345.

Ersan, B. 2018. Teacher opinions on advantages and disadvantages of using interactive whiteboard in primary school. *International Journal of Managerial Studies and Research*, 6(4):12-18.

Faiella, F. & Ricciardi, M. 2015. Gamification and learning: A review of issues and research. *Journal of E-Learning and Knowledge Society*, 11(3):13-21.

Fredricks, J.A., Blumenfeld, P.C. & Paris, A.H. 2004. School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, 74(1):59-109.

Gage, S. 2006. The wonder of trivial machines. *Systems Research and Behavioural Science*, 23(6):771-778.

Garrett, N. 2009. Technology in the service of language learning: Trends and issues. *The Modern Language Journal,* 93(1):697-718.

Glover, D., Miller, D., Averis, D. & Door, V. 2007. The evolution of an effective pedagogy for teachers using the interactive whiteboard in mathematics and modern languages. *Learning, Media and Technology*, 32(1):5-20.

Goodhue, D., Lewis, W. & Thompson, R. 2012. Does PLS have advantages for small sample size or non-normal data. *MIS Quarterly*, 36(3):981-1001.

Gray, R. 2013. Taking technology to task: The skill content of technological change in early twentieth century United States. *Explorations in Economic History*, 50(3):351-367.

Hall, I., & Higgins, S. 2005. Primary school students' perceptions of interactive whiteboards. *Journal of Computer Assisted Learning*, 21(2):102-117.

Henning, G.W., 2012. Leveraging student engagement for student and institutional success, *About Campus*, 17(4):15-18.

Hill, D.L. & Fielden, K. 2017. Use of Mentimeter to promote student engagement and inclusion. *Pedagogy in Practice Seminar*, Carlisle, UK, 18 December.

Huang, R., Spector, J.M. & Yang, J. 2019. Introduction to educational technology. In Huang, R., Spector, J.M. & Yang, J. (eds). *Educational technology: A primer for the 21st century*. Berlin: Springer: 3-31.

Ishtaiwa, F.F. & Shana, Z. 2011. The use of interactive whiteboard (IWB) by pre-service teachers to enhance Arabic language teaching and learning. *Learning and Teaching in Higher Education: Gulf Perspectives*, 8(2):17-34.

Isingoma, P. 2014. Overcrowded classrooms and learners' assessment in primary schools of Kamwenge district, Uganda. Unpublished master's thesis, University of South Africa, Pretoria.

Issa, A.S.A. 2020. Teachers' and students' views on using smart boards in teaching and learning English as a foreign language. Unpublished master's thesis, Middle East University, Amman.

Januszewski, A. & Molenda, M. 2008. Technology: A definition with commentary. *British Journal of Education,* 40(1):185-195.

Jones, P., Kervin, L. & McIntosh, S. 2011. The interactive whiteboard: Tool and/or agent of semiotic mediation. *The Australian Journal of Language and Literacy,* 34(1):38-60.

Karademir, A., Yaman, F. & Saatçioğlu, Ö. 2020. Challenges of higher education institutions against COVID-19: The case of Turkey. *Journal of Pedagogical Research*, 4(4):453-474.

Kemmis, S., McTaggart, R. & Nixon, R. 2014. *The action research planner: Doing critical participatory action research*. Berlin: Springer.

Kent, D. 2019. Plickers and the pedagogical practicality of fast formative assessment. *Teaching English with Technology*, 19(3):90-104.

Keppens, K., Consuegra, E., Goossens, M., De Maeyer, S. & Vanderlinde, R. 2019. Measuring pre-service teachers' professional vision of inclusive classrooms: A video-based comparative judgement instrument. *Teaching and Teacher Education*, 78(1):1-14.

Kirbas, A. 2018. Student views on using smart boards in Turkish education. *Universal Journal of Educational Research*, 6(5):1040-1049.

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

Krisbiantoro, B.2020. The effectiveness of gamification to enhance students' mastery on tenses viewed from students' creativity. *Journal of Advanced Multidisciplinary Research*, 1(2):73-97.

Kriswinardi, G.T., Nitiasih, P.K. & Dambayana, P.E. 2017. An analysis of using video on teaching speaking in EFL classroom of the eleventh-grade students of SMA N 4 Singaraja in academic year 2017/2018. *Journal Pendidikan Bahasa Inggris Undiksha*, 5(2).

Kuh, G.D. 2009. What student affairs professionals need to know about student engagement. *Journal of College Student Development*, 50(6):683-706.

Lackmann, S., Léger, P.M., Charland, P. & Aubé, C. 2021. The influence of video format on engagement and performance in online learning. *Brain Sciences*, 11(2):128.

Lamberth, T. 2012. Interactive whiteboard use: The catalyst of student achievement. Unpublished PhD thesis, University of Southern Mississippi, Mississippi.

Little, C. 2016. Mentimeter smartphone student response system. *Compass: Journal of Learning and Teaching*, 9(13):267-271.

Littlejohn, S.W. & Foss, K.A. 2009. *Encyclopedia of communication theory*. Thousand Oaks: Sage.

Lu, S.J. & Liu, Y.C. 2015. Integrating augmented reality technology to enhance children's learning in marine education. *Environmental Education Research*, 21(4):1350-4622.

Maryam, B., Sören, H. & Gunilla, L. 2019. Putting scaffolding into action: Preschool teachers' actions using interactive whiteboard. *Early Childhood Education Journal*, 48(1):79-92.

Masita, M. & Fitri, N. 2020. The use of Plickers for formative assessment of vocabulary mastery. *Ethical Lingua: Journal of Language Teaching and Literature*, 7(2):311-320.

Mayer, R. 2002. The psychology of learning and motivation. *Elsevier Science*, 41:85-139.

McCargo, M.G. 2017. The effects of Plickers as response cards on academic engagement behaviour in high school students. Unpublished master's thesis. University of Southern Mississippi, Mississippi.

McMillan, J.H. & Schumacher, S. 2010. *Research in education: Evidence-based inquiry, MyEducationLab series*. 7th ed. London: Pearson.

Miles, M., Huberman, M. & Saldaña, J. 2014. *Qualitative data analysis*. 3rd ed. Thousand Oaks: Sage.

Mo, S. 2011. Evidence on instructional technology and student engagement in an auditing course. *Academy of Educational Leadership Journal*, 15(4):149.

Mohin, M. Kunzwa, L. & Patel, S. 2022. Using Mentimeter to enhance learning and teaching in a large class. *International Journal of Educational Policy Research and Review*, 9(2):48-57.

Motala, S. & Carel, D. 2019. Educational funding and equity in South African schools. In N. Spaull & J.D. Jansen (eds). *South African schooling: The enigma of inequality*. London: Springer: 67-85.

Murcia, K. 2014. Interactive and multimodal pedagogy: A case study of how teachers and students use interactive whiteboard technology in primary science. *Australian Journal of Education*, 58(1):74-88.

Musliha, S. & Purnawarman, P. 2020. Using Mentimeter for eliciting the students' responses in formative assessment practice. *Advances in Social Science, Education and Humanities Research*, 508:318-325.

Muthusamy, N. 2015. Teachers' experiences with overcrowded classrooms in a mainstream school. Unpublished master's thesis, The University of Kwazulu-Natal, South Africa.

Nowell, L.S., Norris, J.M., White, D.E. & Moules, N.J. 2017. Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1):1-13.

Obaid, S.A. 2022. The effect of smart board on students' engagement in English. *International Journal of Research in Social Sciences & Humanities*, (12):52-64.

Önal, N. 2017. Use of interactive whiteboard in the mathematics classroom: Students' perceptions within the framework of the technology acceptance model. *International Journal of Instruction*, 4(10):67-86.

Patton, M.Q. 2015. *Qualitative research and evaluation methods*. 4th ed. Thousand Oaks: Sage.

Pichardo, J.I., López-Medina, E.F., Mancha-Cáceres, O., González-Enríquez, I., Hernández-Melián, A., Blázquez-Rodríguez, M., Jiménez, V., Logares, M., Carabantes-Alarcon, D., Ramos-Toro, M., Isorna, E., Cornejo-Valle, M. & Booras-Gene, O. 2021. Students and teachers using Mentimeter: Technological innovation to face the challenges of the

COVID-19 pandemic and post-pandemic in higher education. *Educational Sciences,* 11(11):667.

Prayudha, S. 2021. Video based learning as a media for teaching English during pandemic COVID-19. *Journal of Language Intelligence and Culture*, 2(1):1-11.

Rosmaladewi, R., Abduh, A. & Basri, M. 2020. English lecturers' experiences on professional development in Indonesian polytechnics. *International Journal of Language Education*, 4(2):314-321.

Rudolph, J. 2018. A brief review of Mentimeter – A student response system. *Journal of Applied Learning & Teaching*, 1(1):35-37.

Sachdeva, S. & Kaur, R. 2014. A review on digital image compression techniques. *International Journal on Recent and Innovation Trends in Computing and Communication*, 2(7):1909-1913.

Schindler, L.A., Burkholder, G.J., Morad, O.A. & Marsh, C. 2017. Computer-based technology and student engagement: A critical review of the literature. *International Journal of Educational Technology in Higher Education*, 14:1-30.

Saettler, L.P. 1990. *The evolution of American educational technology*. Englewood: Lawrence Erlbaum Associates.

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P., Koehler, M.J. & 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):123-149.

Sharma, D. & Sharma, J. 2023. Evolution of gamification, its implications, and its statistical impact on the society. *ShodhKosh Journal of Visual and Performing Arts*, 4(2):8-20.

Sherin, M. & van Es, E. 2005. Using video to support teachers' ability to notice classroom interactions. *Journal of Technology and Teacher Education*, 13(3):475-491.

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

Sim, J. & Waterfield, J. 2019. Focus group methodology: Some ethical challenges. *Qualitative and Quantitative Research*, 53:3003-3022.

Singh, G. 2020. Using social media and digital marketing tools and techniques for developing brand equity with connected consumers. In Kumar, P. & Singh, G. (eds). *Handbook of research on innovations in technology and marketing for the connected consumer*. Pennsylvania: IGI Global: 336-355

Sjönvall, J. 2015. Interactive whiteboards English teachers' integration of the IWB in English language teaching. Unpublished PhD thesis, Linnėuniversitetet, Kalmar.

Slavin, R. & Smith, D. 2009. The relationship between sample sizes and effect sizes in systematic reviews in education. *Educational Evaluation and Policy Analysis,* 31(4):500-506.

Smith, H.J., Higgins, S., Wall, K. & Miller, J. 2005. Interactive whiteboards: Boon or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning*, 21(2):91-101.

South Africa. Department of Education. 2004. *Annual report on post-provisioning norm*. Pretoria: Government Printer.

South Africa. Department of Basic Education. 2023. *Annual report on post-provisioning norm*. Pretoria: Government Printer.

Stake, R.E. 2005. Qualitative case studies. In Denzin, N.K. & Lincoln, Y.S. (eds). *The handbook of qualitative research*. 3rd ed. London: Sage.

Stroud, R., Drayton, B., Hobbs, K. & Falk, J. 2014. Interactive whiteboard use in high-tech science classrooms: Patterns of integration. *International Journal of Emerging Technologies in Learning*, 9(9):41-49.

Tefo, R. & Pitsoane, E. 2023. Students' perceptions of the digital access centres at the University of South Africa. *Research in Social Sciences and Technology*, 8(4):360-371.

Tertemiz, N., Kalyon, S., Can, D., Duzgun & Serkan. 2015. Views of primary school teachers and students about the interactive whiteboard. *Procedia – Social and Behavioral Sciences*, 186:1289-1297.

Toscu, S. 2013. The impact of interactive whiteboards on classroom interaction in tertiary level English as a foreign language class. Unpublished master's thesis, Bilkent University, Ankara.

Ugwu, C. & Eze, V. 2023. Qualitative research. *Journal of Computer and Applied Sciences*, 8(1):20-35.

Vallely, K. & Gibson, P. 2018. Engaging students on their devices with Mentimeter. *Compass: Journal of Learning and Teaching,* 11(2).

van Der Berg, S., Burger, C., Burger, R., de Vos, M., du Rand, G., Gustafsson, M., Moses, E., Shepherd, D., Spaull, N., Taylor, S., van Broekhuizen, H. & von Fintel, D. 2016. *Low quality education as a poverty trap: Teacher distribution disparities in South Africa*. Stellenbosch: Stellenbosch University.

van Uden, J.M., Ritzen, H. & Pieters, J.M. 2014. Engaging students: The role of teacher beliefs and interpersonal teacher behavior in fostering student engagement in vocational education. *Teaching and Teacher Education*, 37:21-32.

van Wyk, M. 2019. Pre-service teachers' preparedness for fourth industrial revolution teaching and learning. Unpublished master's thesis, Cape Peninsula University of Technology, Cape Town.

West, J. & Meier, C. 2020. Overcrowded classrooms – The Achilles heel of South African education? *South African Journal of Childhood Education*, 10(1):1-10.

Williams, M. & Moser, T. 2019. The art of coding and thematic exploration in qualitative research. *International Management Review*, 15(1):45-55.

Wood, T.A., Brown, K. & Grayson, J.M. 2017. March. Faculty and student perceptions of Plickers. In *ASEE Zone II Conference*, 4.

Young, J.C., Quayle, M.R., Adams, J.W., Bertram, J.F. & McMenamin, P.G. 2019. Three-dimensional printing of archived human fetal material for teaching purposes. *Anatomical Sciences Education*, 12(1):90-96.

Zeegers, Y. & Elliot, K. 2018. Who's asking the questions in classrooms? Exploring teacher practice and student engagement in generating engaging and intellectually challenging questions. *Pedagogies: An International Journal*, 1(14):17-32.

APPENDICES

APPENDIX A: FOCUS GROUP INTERVIEW QUESTIONS

1) What elements make you want to engage more and less?
2) What did you like and dislike about the IWB? Explain why.
3) What is your perception of the IWB? Do you like using the whiteboard?
4) Did you engage more when the teachers introduced the tool and IWB? What were your thoughts? How did you feel?
5) Have you understood the work content better when you use the tool?
6) What would be the ideal class? Describe.

APPENDIX B: OBSERVATION SCHEDULE

OBSERVATION GRID			
Site location	**Date:**	**Start time:**	**Stop time:**
Area of observation			
Behaviour: **(Participation, what by whom, where)**			
Context: **(What else is going on)**			
General mood:			
Reflexive comments:			

APPENDIX C: RESEARCH ETHICS CERTIFICATE

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (CPUT HWS-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

09 May 2024
REC Approval Reference No:
CPUT/HWS-REC 2024/S22

Faculty of Health and Wellness Sciences

Dear Ms Inga Sharter

Re: APPLICATION TO THE HWS-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to **Ms Inga Sharter** for ethical clearance. This approval is for research activities related to research for **Ms Inga Sharter** at the Dalweide Primary school in the Western Cape.

TITLE: **Interactive whiteboard to enhance learning engagement in large classes in Western Cape primary school**

Supervisor: Dr Faiq Waghid

Comment:

Approval will not extend beyond 09 May 2025. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the CPUT HWS-REC in December of that particular year, for the CPUT HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Ms Carolynn Lackay
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

APPENDIX D: WCED APPROVAL LETTER

Western Cape Government
Education

Directorate: Research

meshack.kanzi@westerncape.gov.za
Tel: +27 021 467 2350
Fax: 086 590 2282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 3A66270C13000021-20240520
ENQUIRIES: Mr M Kanzi

Ms Inga Sharter
G244 Lavie Estate, Klein Parys
Paarl
7646

Dear Inga Sharter,

RESEARCH PROPOSAL: THE USE OF AN INTERACTIVE WHITEBOARD (IWB) TO ENHANCE LEARNER ENGAGEMENT IN A LARGE CLASS IN WESTERN CAPE PRIMARY SCHOOL.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **5 June 2024 till 30 September 2025.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Mr M Kanzi at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards,
Meshack Kanzi
Directorate: Research
DATE: 5 June 2024

APPENDIX E: CONSENT FORM

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

[Informed Consent form for Parents of the participants]

This Informed Consent Form is for parents of the participants who are invited to participate in a research study. The title of our research project is " "Interactive whiteboard to enhance learning engagement in large classes in Western Cape primary school".

[Name of Proposal and version- "Interactive whiteboard to enhance learning engagement in large classes in Western Cape primary school".**]**

[Name of Principal Investigator –]

[Contact Number –]

[Name of Supervisor –]

[Contact Number –]

This Informed Consent Form has two parts:

- **Information Sheet (to share information about the research)**
- **Consent form (for signatures if you**

agree to take part) You will be given a copy of

the full Informed Consent Form

PART I: Information Sheet Introduction

You were selected as a possible participant in this study. A study will be done on how can the lack of learner participation in a large classroom be address through the use of IWB? Before the study will be carried out, the researcher will first receive permission from the following. Permission from the principal and parents. The learners are all minors, so the researcher will grant permission from their parents. The information below gives details about the study to help you decide whether you would

want to participate.

In the context of this study, due to a high learner to teacher ratio, many of the afore mentioned negative implications are prevalent. The teacher to learner ratio in the school has changed from 1:40 in 2016 to 1:45 in recent years. This is considerably larger than the Department of Basic Education's description of a "large classroom" which has a teacher to learner ratio of 1:37 (South Africa, 2020). This has resulted in much frustration and stress in attempting to deliver an effective pedagogical experience. Many learners will not speak, are more withdrawn, and not responding to questions during classroom discussions or asking for help. Learner engagement remains important to learning and achievement, and it's likely that teachers will need to find new ways to motivate and engage their learners. Although teachers are able to do little about learner to teacher ratios, the use of educational technology by teachers may assist teachers to cope with large classes where learner disengagement is prevalent. This study will explore how can the lack of learner participation in a large classroom can be addressed through the use of IWB.

In the accompanying consent forms, all participants' rights will be outlined and clarified. These rights include the right to refuse to participate in the study and to withdraw at any time, to be informed about the study's goals, what will happen to them, and what they will be asked to do if they participate.

Participants will be given the right to privacy and anonymity. Participants' right to privacy will be protected, and their anonymity will be preserved. Pseudonyms will also be used to protect the respondents' identities.

The researcher will refrain from naming the participants with their real names. Information will not be shown or discussed with and for anyone else. All work saved on a computer will be password protected and hard copy files such as signed consent forms, filled interviews and observation protocols will be in a lock file cabinet and personal identities from study documents will be remove as soon as possible. Additionally, a formal assurance on the invitation letters and consent forms will be given and participants will be assured that the researcher will fulfil the conditions as stated regarding confidentiality

Purpose of the research

The teacher-to-learner ratio in some South African schools has changed from 1:40 in 2016 to 1:45 in recent years. This is considerably larger than the Department of Basic Education's description of a "large classroom" with a teacher-to-learner ratio of 1:37 (South Africa, 2020). This has resulted in frustration and stress in attempting to deliver an effective pedagogical experience. Many learners will not speak, are more withdrawn, and not responding to questions during classroom discussions or asking for help. Learner engagement remains important to learning and achievement, and it's likely that teachers will need to find new ways to motivate and engage their learners. Although teachers can do little about learner-to-teacher ratios, the use of educational technology by teachers may assist teachers in coping with large classes where learner disengagement is prevalent. This study will explore how the lack of learner participation in a large classroom can be addressed using IWB.

Type of Research Intervention

The data will be collected through focus group interviews, observation schedules, and class activities. The study will make use of one focus group. Focus group interviews may make participants more comfortable engaging in a group (du Plooy-Cilliers et al., 2014:175). All participants will be placed in one group, and sessions will occur after school. All sessions will be one and a half hours at maximum. The researcher will make sure all the questions are understood correctly, simple language and grammar will be used and that all the meaning of the questions are clear to ensure that all participants stay on the topic during the conversation. Participant observation will be used, and the researcher will participate actively in the group. All sessions will take place at the library, where there is air conditioning, comfortable chairs and a relaxing atmosphere so that the participants will be at ease. Denscombe (2010:196) states that observations draw on direct evidence and witness events first-hand. Muthsumay (2015:18) informs that observation means that the researcher goes to a school or classroom and observes what is taking place.

This method will help gain insight into what is happening in the classroom. Therefore, this observation will help the researcher to see and understand what the participants are doing and compare it to what they are saying. Four classes will be observed twice every week for three weeks long. As this is an Action Research study, it will have three cycles; therefore, three interviews will take place after every cycle (see Appendix A). All interview data will be transcribed.

Participant selection

The population of this study are learners at a primary school in the Western Cape, Paarl area. The study will make use of “purposive” sampling. By implication, six learners will be selected and partake in this study whom the researcher thinks will provide the best information.

Focus groups will be used, affording learners to talk more openly when they are in a group. Data collection will be in the form of group interviews and observation schedules.

The study will make use of one focus group who are all similar based on certain criteria. Focus group interviews may make participants more comfortable engaging in a group (du Plooy-Cilliers et al., 2014:175) All participants will be placed in one group, and sessions will take place after school. All sessions will take place at the library, where there is air conditioning, comfortable chairs and a relaxing atmosphere so that the participants will be at ease. All sessions will be one and a half hours at maximum.

Procedures and Protocol

All participants will be placed in one group, and sessions will occur after school. All sessions will be one and a half hours at maximum. The researcher will make sure all the questions are understood correctly; simple language and grammar will be used and that all the meaning of the questions are clear to ensure that all participants stay on the topic during the conversation. Participant observation will be used, and the researcher will participate actively in the group. All sessions will take place at the library, where there is air conditioning, comfortable chairs and a relaxing atmosphere so that the participants will be at ease.

A. Description of the Process

The data will be collected through the use of focus group interviews, observation schedules, individual learner reflections, and from class activities. Focus group interviews may afford participants to be more comfortable engaging in a group (du Plooy-Cilliers et al., 2014:175). Denscombe (2010:196) states that observations draw on direct evidence and witnessing events first-hand. Muthsumay (2015:18) informs that observation means that the researcher goes to a school or classroom and observes what is taking place. This method will help gain insight into what is happening in the classroom. During the study, classwork will be given to check if the use of IWB stimulates learning. Learner individual reflections in focus group interviews will be used in determining whether IWB was effective. The duration of the fieldwork will be one month. The study will have three cycles; therefore, three interviews will take place after every cycle (see Appendix A). The data will be written up and interviews transcribed.

Duration

The duration of the research will be one month. See observation schedule and questionnaire attached.

Risks

This study's participation may be exposed to high-level risk. The researcher, for example, is aware that the participants may feel intimidated, or that the information they are about to provide may reflect negatively on the teacher. In this respect the researcher will make sure to remind the participants on a regular basis that their responses to the interview questions will be kept confidential and that the identity of the school will not be shared with the general public.

As a researcher, it will be vital to commit to protecting the rights and well-being of participants and the institution, ensuring that no-one is exposed to any harm, in terms of reputation or otherwise, as a result of the study. The researcher therefore will make the necessary effort and commitment to maintain the informants' privacy, confidentiality and general research ethics principles during the data collection and compilation of the study. Since the researcher is employed at the school where the data will be collected, the researcher is aware that participants must be allowed to talk freely and that all answers must be recorded verbatim.

Benefits

The results of this study will enable colleague teachers who might also encounter learners participating in lessons to get assistance. They can employ the required digital technologies to tackle this challenge.

Reimbursements

No money will be provided to participants.

Confidentiality

Participants will be given the right to privacy and anonymity. Participants' right to privacy will be protected, and their anonymity will be preserved. Pseudonyms will also be used to protect the respondents' identities.

The researcher will refrain from naming the participants with their real names. Information will not be shown or discussed with and for anyone else. All work saved

on a computer will be password protected and hard copy files such as signed consent forms, filled interviews and observation protocols will be in a lock file cabinet and personal identities from study documents will be remove as soon as possible. Additionally, a formal assurance on the invitation letters and consent forms will be given and participants will be assured that the researcher will fulfil the conditions as stated regarding confidentiality.

Sharing the Results

To mitigate coercion parents and learners have a right to withdraw from the study at any time. Once the study has concluded, parents will be informed about the data collection process. Participant anonymity will be ensured at all times. The information will be stored safely.

Right to Refuse or Withdraw

In the accompanying consent forms, all participants' rights will be outlined and clarified. These rights include the right to refuse to participate in the study and to withdraw at any time, to be informed about the study's goals, what will happen to them, and what they will be asked to do if they participate.

Who to Contact

This proposal has been reviewed and approved by the Health and Wellness Sciences Research Ethics Committee (HWS-REC), at the Cape Peninsula University of Technology, which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the HWS-REC, contact Ms Nomathemba Seth, the secretariat.

Contact Details:

Tel: +27 21 9596917

E-mail: sethn@cput.ac.za

PART II: Consent form

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked to have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Declaration by participant

By signing below, I A. Rederick agree that my child may take part in a research study entitled (**"**Interactive whiteboard to enhance learning engagement in large classes in Western Cape primary school".).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Dalweide Primary school on 26/08/04.

_____

Signature of participant

_____

Signature of witness

PART II: Consent form

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked to have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Declaration by participant

By signing below, I A. Rederick agree that my child may take part in a research study entitled (**"**Interactive whiteboard to enhance learning engagement in large classes in Western Cape primary school".).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been answered.
- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Dalweide Primary school on 26/08/04.

Signature of participant

Signature of witness

APPENDIX F: EDITOR'S LETTER

PROOF-READING

DR LEE-ANNE ROUX

EDITOR | PROOFREADER

+27 82 825 7325
leeanne@proof-reading.co.za
www.proof-reading.co.za

PROFESSIONAL EDITING SERVICES

PHD PRACTICAL THEOLOGY (SU) • MTH PRACTICAL THEOLOGY (SU) • BA (HONS) PSYCHOLOGY (UNISA)
BTH (HONS) PRACTICAL THEOLOGY (UNISA) • BTH PASTORAL COUNSELLING (UNISA)

16 November 2024

TO WHOM IT MAY CONCERN

RE: LANGUAGE EDITING

This letter serves to confirm that I have edited the thesis titled:

INTERACTIVE WHITEBOARD TO ENHANCE LEARNING ENGAGEMENT IN LARGE CLASSES IN WESTERN CAPE PRIMARY SCHOOLS

By

INGA SHARTER

This certificate does not cover any alterations made subsequent to the editing process.

Please feel free to contact me if you need any further information.

Yours sincerely,

Dr Lee-Anne Roux