Mapping Multimodal Affordances of the Interactive Whiteboards into Teaching of Grade 11 Mathematics Content: A Case Study of five Gauteng Township Secondary Schools

By

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Declaration page

I, Vincent Mahlaseletse Montjane, student number 474704, hereby declare that the thesis:

"Mapping Multimodal Affordances of the Interactive Whiteboards into Teaching of Grade 11 Mathematics Content: A Case Study of five Gauteng Township Secondary Schools"

Submitted at the University of Witwatersrand, acknowledge is my own work.

Furthermore, I confirm that:

1. All sources have been referenced according to APA style.
2. I followed ethical considerations for data collection

Signature: ……………………………………

Dedication

I dedicate this study to my parents Mashikane Montjane and Mahlasele Montjane. I draw inspiration from their selfless and unwavering support they have always shown to the entire family. I am forever grateful for their love and presence in my life. I also dedicate it to my family, extended family and friends.

Acknowledgement

I extend my sincere gratitude to my supervisor, Prof Reuben Dlamini for his assistance and professional guidance throughout my PhD journey. Your constant encouragement, insightful feedback and unwavering support have been instrumental in shaping this study. Most importantly, your belief in my abilities fuelled my perseverance.

To my wife, Sarah Ditata Montjane, thank you for your unconditional love and support. You have always pushed me to complete this PhD journey. You are my pillar of strength, and I thank you for stepping up to take my responsibilities when I was busy with my studies. Special thanks go to my children; Chris, Gaopaleloe and Tshephang for ensuring that Daddy's tea is always prepared and served on time. My gratitude goes to all my siblings for your endless love and words of encouragement.

To my parents, Mashikane Montjane and Mahlasele Montjane, I thank you for always believing in me and I appreciate everything you have done for me. Your love and caring hearts have kept me strong every day.

To all the teachers who participated in this study, I truly appreciate your participation and cooperations during the study. My gratitude goes to the principals of the five schools for allowing your teachers to participate in this study.

Gratitude is owed to my friends and colleagues for your selflessness; you have been there for me when I needed you the most.

Amen! Re a leboga!!!

Abstract

Technology penetration in Gauteng township secondary schools was brought to improve teaching practices which could stop learners from becoming victims of the education system. The study presents findings from five schools where Interactive White Boards were introduced as one of the technologies which could improve teaching and learning. A pragmatist lens was used to understand how teachers' preparedness and attitudes affect the effectiveness of using Interactive Whiteboards into the teaching of grade 11 Mathematics content.

The study used a mixed method research design to gain knowledge from data produced from 10 teachers. The study is lensed under The Unified Theory of Acceptance and Use of Technology (UTAUT) model which served as an integral theoretical foundation for this research. The UTAUT model which guide users on the intentions to use a technology was reviewed and interrogated based on the context of the research study. Experience was redefined in relation to the UTAUT model, and a new model emerged as Teacher Preparedness and Usage of IWB model.

The findings reveal that teacher preparedness cannot be attributed to a single factor. The human and non-human characteristics contribute to how we interact with the world. Teachers carry different attitudes towards IWB usage. Evidence from this study showed that those with high experience had similar challenges of integrating IWB into Mathematics content as novice teachers. Although teachers applied constructivist principles, they did not innovatively use the IWB to teach Mathematics, resulting in disorganised teaching approaches. Their teaching approaches are limited to the classroom experiences, with no intentions to engage learners outside their school environment. A blended teaching approach which encourages inclusivity and social presence was lacking and as such, constant interaction and collaboration in and outside the classroom could not be realised. The study also recognises that teacher preparedness in technology education remains a challenge in Gauteng schools because teachers lack pedagogical skills of integrating IWB into Mathematics content.

Considering teachers' unpreparedness in using IWB to teach Mathematics, the study proposes a teacher preparation for IWB integration within Mathematics content framework which could assist policy makers to follow when a new technology is introduced for teaching and learning. The flexibility of the framework makes it adoptable at different phases of the ICT initiative because it guides initiators and implementers of Mathematics curriculum within a digital sphere. The study recommends therefore that a feasible study is necessary for any ICT initiative to avoid recurring mistakes. Where ICT training is provided, it must be contextualised, systematic and aligned to teachers' subjects. Otherwise, teachers

will continue to struggle in their attempt to integrate ICTs into the curriculum because the initiative itself lacks structural systems for technology implementation.

Table of Contents

List of Tables and Figures

Tables

Figures

List of Acronyms

CAPS	Curriculum and Assessment Policy Statement
C-TPB-TAM	Combined Theory of Planned Behaviour/Technology Acceptance Model IDT Innovation diffusion theory
DBE	Department of Basic Education
DoE	Department of Basic Education
GDE	Gauteng Department of Education
FET	Further Education and Training
GoL	Gauteng online laboratories
ICT	Information and Communication Technology
IWB	Interactive Whiteboard
MM	Motivation Model
MPCU	The Model of PC Utilization
NCTM	National Council of Teachers of Mathematics
NCS	National Curriculum Statement
NDP	National Development Plan
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TIMSS	Trends in International Mathematics and Science Study
TPACK	Technological Pedagogical Content Knowledge
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TTF	Task-Technology Fit model
SACMEQ	South African and Eastern Consortium for Monitoring Educational Quality
SCT	Social Cognitive Theory
SSIP	Secondary School Improvement Plan
STEM	Science, Technology, Engineering and Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization
UTAUT	The Unified Theory of Acceptance and Use of Technology

List of Appendices

Chapter 1 Introduction

1.1 Background of the Study

The South African curriculum has taken different forms since the dawn of democracy. Throughout the past three decades, the transition of the education landscape gave birth to different curriculums including the current Curriculum and Assessment Policy Statement (CAPS). Although the country was in a phase of addressing apartheid legacy challenges ranging from lack of schools, insufficient classrooms and lack of learning and teaching materials, the Department of Education continued to implement curriculum strategies which embraced inclusivity and equity. The inequalities amongst South African schools have always made it difficult for teachers to produce desired results in their implementation of any curriculum statement. CAPS curriculum is not an exception, because societies are still facing education, social and economic challenges in their schools.

The Department of Basic Education’s (DBE) amended the National Curriculum Statement (NCS) which resulted in the formation of CAPS curriculum which was specific in terms of what teachers should teach and when. The intention was to ensure that teachers implement a curriculum that empowers society to be self-sufficient and teachers and learners to do well in schools and work closely with the society to improve the quality of education (Magumbo, 2022). Teaching and learning approaches within the CAPS curriculum advocate for active and student-centred approaches. These approaches involve active participation during lessons and open mind set with abilities to interact and collaborate with others.

Malik and Zhu (2023) are in favour of exposing learners to different teaching and learning methods, but they also recommend the introduction of Information and communication Technologies (ICTs) to supplement classroom practices. However, the use of correct methodologies that suite the ICT concern is of utmost important (Malik & Zhu, 2023). There is no doubt that incorporating ICT resources into subject content will obviously affect teaching methods. In fact, the success of any educational ICT programme is entirely dependent on how these resources are integrated into school curriculum. These ICT resources have a potential of addressing educational problems only if they are used appropriately (Reuter, 2022). Incorporating ICTs with correct teaching strategies increase learner engagement and participation in the classroom. Similarly, applying correct Technological Pedagogical Content Knowledge (TPACK) creates a more learner centred approach and active learning (Tanjung, 2022).

To narrow the access gap, the Gauteng Department of Education (GDE) has introduced a new strategy called Paperless Classroom Solution in township secondary schools. This strategy is aimed at addressing challenges ranging from lack of technological access, ICT kills and poor ICT integration. The DBE equipped grade 11 classrooms with IWBs, learner tablets and teacher laptops in most no fee-paying township schools in 2016. The no fee-paying schools are categorised under quintile one to three and these are schools located in the previously disadvantaged areas, such as townships and squatter camps. To improve school performance, the strategy began in grade 12 and continued to expand to junior grades as years progressed. To ensure teachers possess skills to use deployed technologies, both grade 11 and 12 teachers were trained on how to teach with IWB. However, these initiatives were not sufficient to yield good grades considering that learner performance remained low in Mathematics. Furthermore, the statistics in the Science, Technology, Engineering and Mathematics (STEM) subjects across the country show poor performance records in Mathematics (Chand, Chaudhary, Prasad, & Chand, 2021). In fact, poor performance in grade 11 has affected Grade 12 Mathematics results terribly. Based on the DBE's records, majority of learners who wrote Mathematics in grade 12 struggled to obtain 50% pass mark (Sonkqayi, 2021). Internationally, South African's Mathematics education is rated amongst the lowest by Trends in International Mathematics and Science Study (TIMSS) (Zhou, Makgakga, & Dhlamini, 2022). Despite the introduction of IWB, it was assumed that performance would change in the STEM subjects, Mathematics remains problematic and challenging to students.

Teaching and learning of Mathematics content continues to take centre stage, amidst the challenges and the struggles that teachers and learners face in the teaching and learning of this subject and produce the desired performance (Karim & Zoker, 2023). Mathematics content and its application towards solving real time situations remain critical to learners. However, learning and teaching of Mathematics content has been unsatisfactory especially in the FET phase. Synopsis of literature show that many strategies have been adopted to improve mathematics performance. According to Karim and Zoker (2023), the use of ICTs to teach and learn Mathematics has shown positive classroom practices because of what these technologies possess. Although there are doubts in relation to how teaching and learning of Mathematics with ICTs influences learner performance, the multimodality of ICTs affords learners a better comprehension and conceptualisation of concepts which influence their performance (Darmayanti, Sugianto, Baiduri, Choirudin, & Wawan, 2022).

The adoption of technology in Mathematics education has grown exponentially over the years. ICTs are gradually penetrating Mathematics classrooms in most South African township and rural schools (Maqoqa, 2025). These technologies are perceived as potential catalyst for change and the assumption is, learner will benefit enormously when they are properly integrated in various subject (Karim & Zoker, 2023). Although, there are many praises around these technologies, it is evident that most learners still become victims of bad teaching of Mathematics concepts even in the presence of technologies such as IWBs. This has been attributed poor integration of technologies in Mathematics lessons.

Teachers are unable to leverage IWB's pedagogic opportunities due to failure of developing pedagogical approaches that suit the use of IWBs. They are left with no choice but to teach in IWB classrooms with mismatching pedagogic approaches. Ebrahim (2022) argue that such teachers are unable to use correct pedagogical approach and IWB's interactivity to impact on teaching and learning. Clashing of pedagogic practices become evident since teachers are unable to fully utilize the IWB as pedagogic tools that enhance teaching of Mathematics in the classroom (Ebrahim, 2022).

The provision of these ICT resources has triggered debates around the education system and some professionals regard this initiative as a wasteful expenditure. Critics of ICT projects view them as another failing initiative by the government since it is currently battling to "sufficiently and inclusively deliver to its citizens in a digital manner" (Mosehlana & Sebola, 2020). Moreover, some teachers regard these resources as modern technologies that add no value to the curriculum and are imposed on them by superiors (Na-Allah, 2019). On other hand, others perceive ICTs as interactive tools that enable teachers to manipulate information to suit their teaching methods (Luo, Tan, He, & Wu, 2023). The way in which teachers perceive ICT resources differs from person to person. Similarly, the way township secondary school teachers use IWB to teach Mathematics, varies according to the user's willingness to use the technology, technological skills, and technological pedagogical knowledge, just to mention a few. This has necessitated this research study to find out if teachers' preparedness and attitudes affect the integration of IWBs into teaching of Mathematics content.

In the next section, background information about the status of e-Learning in South Africa has been provided. Initiatives by the post-apartheid government in addressing the inequalities and other socio-economics factors emanating from the apartheid system are discussed in this section. Moreover, attempts for provision of ICT resources to support teaching and learning of Mathematics in the classroom have also been clarified.

1.2 The status of e-Learning in education

The new democracy in South Africa necessitated the education system to redress the education challenges of the apartheid era; ranging from unequal distribution of educational resources, lack of proper learning facilities and poor access of ICT resources. To address technological discrepancies, the sitting government by then formulated a White Paper on e-Education policy in 2004 which served as a route map for ICT programmes. Among other things, the White Paper on e-Education policy was put in place to narrow the digital gap that existed amongst schools hence it stresses the importance of schools having access to ICT resources. For Jagatheesaperumal, Ahmad, Al-Fuqaha and Qadir (2024), access to ICT enable learners to have access to unlimited digital content and online interaction with peers and content expects. Although access to ICT resources is important, one should also stress that ICTs resources have their own challenges. Depending on the context and content to be taught through ICTs, they can either enhance or distract teaching and learning especially if they are poorly used. Therefore, one would not regard ICTs as silver bullet for any educational situation.

In trying to transform the education system in South Africa, the education ministry started procuring ICT resources for the previously disadvantaged schools. Records showed that most previously advantaged white schools are well equipped with computer laboratories and state of the art equipment or tools. In contrast, rural and township schools are under-resourced, with poor learning and teaching environments (Mncube & Ngema, 2023). The ICT accessibility gap was narrowed by introducing various programmes or projects in various provinces, especially in townships, squatter camps and rural areas. Some of these high budget ICT based projects include Khanya project and technology in education project that was rolled out in Western Cape while Gauteng province has Gauteng Online and Paperless Classroom project.

Although the White on Education was formulated in 2004, Western Cape and other provinces were already introducing ICT programmes to address challenges on the ground. In 2002, Gauteng introduced a mega project called Gauteng Online (GoL) that ensured public schools have a computer lab with at least 25 desktops, a printer, server, and TV screen. The GoL strategy was meant to address issues related to schools that do not have access to ICT resources, lack of internet access, and absence of ICT resources to support teaching and learning. Although the GoL strategy was good, schools were faced with challenges of implementing the strategy because they were not fully prepared to teach with technology. Besides, average classroom sizes in public township schools have forty learners, therefore it was not practical to give learners equal chances to use the computers. Maintaining the GoL infrastructure was also a nightmare because computers had faults for weeks without being attended to. There were no onsite technicians to troubleshoot and empower teachers on ICT skills. Many schools experienced unstable connectivity and there was no turnaround strategy for resolving these challenges. Some schools stayed for months with challenges, and this resulted in teachers losing interest.

The GoL challenges brought resentment to school communities and gradually, it became a white elephant in many schools. Nonetheless, the digital gap continued to widen between schools which could source for alternative ICT programmes and those who depend on a non-functional GoL laboratories. Narrowing the digital divide is a societal empowerment and transformation, if ICT access is narrowed; it gives opportunities for skills improvement (Ramoroka, 2021). To mitigate the failed strategy, the GDE introduced ten strategic pillars which focused on the holistic challenges faced by schools. In the mist of addressing the social, economic and educational challenges faced by the GDE, a Paperless Classroom Solution strategy was conceived. The Paperless Classroom Solution strategy focused on equipping previously disadvantaged schools which are mainly located in the township with technological devices such as Interactive Whiteboards (IWBs), laptops, tablets, printers and connectivity solution. To support and carefully implement the paperless classroom strategy without fail, the GDE developed ten pillars which served as strategic drivers for educational transformation. The educational change was inevitable because it perused the dream of narrowing ICT access, improve ICT integration, and addressing ICT skills gap. Although the ten pillars aimed at addressing education aspects within Gauteng schools, this study finds pillar number six most relevant because it talks about implementing ICT in education. To ensure that ICT in education is implemented, five key functions were introduced. These functions include connectivity, e-Learning solution, ICT infrastructure, ICT support and teacher development.

During the initial implementation face, the paperless classroom solution started in four township secondary schools, one former previously advantaged school and two primary schools in Gauteng for the academic year 2015. The grouping was then called 5+2 schools, which simply means five (5) secondary schools and two (2) primary schools. By then, only grade 7 and 12 teachers and learners benefitted from this initiative. The following year the project was rolled out in grade 12 classrooms of all no fee-paying township secondary schools. As the programme expanded, grade 11 classrooms were equipped with IWBs in 2017. Currently, only Grade 7 to grade 12 teachers and learners benefit from this programme. This initiative is aimed at empowering teachers and learners with adequate ICT skills and provides an interactive platform through online platforms for active learning.

In making sure that ‘teacher development in the ICT sphere’ is well addressed, the GDE sanctioned the Teacher Development Unit (a section in the GDE structure) and Matthew Goniwe School of Leadership and Governance to coordinate teacher training on ICTs. District facilitators together with teachers from participating schools were trained on how to navigate IWB. Training did not include ways of integrating IWB into the school curriculum. Series of training followed but only basic ICT skills were covered. Both Mathematics facilitators and teachers were victims of this process. Teachers were left with no choice but to use their perceptions on how to integrate IWBs into teaching and learning.

To further ensure that teachers receive immediate technical support in schools, the GDE deployed technicians who attend to technical problems in schools. A technical support centre was established, and it is called Dr Harry Gwala centre. The strategy here was to ensure that technical challenges are addressed immediately and that teaching and learning should not be hindered. Although there was technical support and series of trainings, IWB integration seemed to be a challenge to many teachers.

1.3 The status of Mathematics education

The South African government has developed a plan to improve the quality of education through the National Development Plan (NDP) to realise their 2030 vision (National Planning Commission, 2012). Priority has been put on education with a hope that citizens will be empowered to participate in the global economic society. The NDP’s plan to improve education is meant to eradicate poverty and unemployment by capacitating citizens with skills and knowledge needed for the 21st century such as digital literacy, problem-solving and critical thinking (Matyana & Thusi, 2023). The education system across the world has placed Mathematics education at the forefront of global competence. Proficiency in Mathematics is known to be related to academic, economic and life success in general (Kandeel, 2021). Mathematics education has been linked to the development of critical and abstract thinking, especially conceptual knowledge, procedural knowledge, and procedural flexibility which are necessary for solving Mathematical problems (Kandeel, 2021). What is even more worrying is that South African learner performance in Mathematics is ranked below the international benchmark of 500 points (Kandeel, 2021).

Ransom of money was put aside by the South African government to finance programmes and projects that aim to improve Mathematics education in secondary schools. Evidence can be drawn from the government’s National Development Plan (NDP) which highlights the importance of improving learner achievements in Literacy and Mathematics to be above 50% (National Planning Commission, Department of the Presidency, Republic of South Africa, 2012). On the other hand, the ministry of education is also doubling its efforts to ensure that special grant projects (such as the Dinaledi secondary school project), Public and Private Partners take part in improving Mathematics education. Regardless of all these efforts, reports between 2015 and 2019 from Trends in International Mathematics and Science Study (TIMSS) still places South African Mathematics education far below average level (Spaull, Courtney & Qvist, 2022). Although there was a noticeable increase from 389 to 397 points from 2019 to 2023, this is far from the DBE's plan of improving the average score in the TIMSS score to 420 points in 2022. In fact, South Africa continues to be ranked amongst the poorest performing countries in the world (Spaull et al., 2022). Subsequently, South African was listed amongst poor performing countries in Mathematics in Africa (Taylor, 2021).

Some of the challenges which contribute to the poor Mathematics performance ranges from teachers' lack of mathematical content knowledge, poor teaching strategies and lack of relevant learning and teaching materials and pedagogies to teach Mathematics content, just to mention a few examples. For teachers to produce better Mathematics results, they ought to have relevant content knowledge, adequate resources, and relevant pedagogical approaches. Buchholtz, Kaiser and Schwarz (2023) support the view that teachers' content knowledge has high influence in the quality of teaching. The study conducted in 2022 by the South African and Eastern Consortium for Monitoring Educational Quality (SACMEQ) also indicates that most of Mathematics teachers have limited understanding of the curriculum they are supposed to teach. Records of poor performance in Mathematics in South Africa triggered researchers' interest to investigate teachers' content knowledge and pedagogical practices in the classroom. Poor performance has been linked to teachers' passive delivery of content knowledge which results in surface learning (Chand, Chaudhary, Prasad & Chand, 2021).

The United States of America's National Council of Teachers of Mathematics (NCTM) is encouraging teachers to adopt teaching strategies that focus on learner-centeredness to improve learner performance (Mohamed, Khalil & Awaji, 2023). Over and above a more learner dominant teaching approach, the NCTM sees technology having potential to enhance the teaching and learning of Mathematics education in the classroom. The council further supports the use of technology because it can contribute to project-based learning which encourages identification of a problem, analysis, reflection and decisive decision during Mathematics lessons (Mohamed et al., 2023). From the South African context, the White Paper on e-Education (2004) also sees technology as a transformative tool in education hence it had hoped that "every learner in the general and further education and training bands would be ICT capable by 2013" (p 23). In realizing what White Paper on e-Education argues for, teachers need to have the necessary content, technological and pedagogical knowledge.

Research by the Southern and East Africa Consortium for Monitoring Educational Quality (SACMEQ) indicates that minority of South African Mathematics teachers have desirable content knowledge (Taylor, 2021). On the other hand, the National Education Collaboration Trust report reveals that most teachers are lacking basic ICT skills integration (Kayembe & Nel, 2019). This clearly shows that only few teachers have technological content knowledge. However, Kayembe and Nel (2019) lament the fact that even if teachers are supported to acquire this knowledge, application of this knowledge in a classroom remains a challenge.

The South African 2024 National Senior Certificate Technical report indicates that Mathematics average pass rate in the Further Education and Training (FET) band has been below 70% for the past three years with learner performance in Mathematics very low as compared to other subjects. The report further shows various intervention strategies such as Secondary School Improvement Plan (SSIP) that the National Department has adopted to improve priority subjects including Mathematics. With many strategies that have been developed and implemented, the 100% achievement in Mathematics seems to be a bridge too far to reach. With all these challenges expanding around Mathematics education, Grade 11 teachers are still expected to lay a formidable foundation in terms of content delivery before learners can reach grade 12.

Another contributory factor to the poor learner performance in grade 11 and 12 Mathematics is that teachers find it difficult to teach mathematical concepts in a more practical and meaningful manner especially teachers with less teaching experience (Harefa & Hulu, 2024). While for Montjane (2018), the chalkboard that is used by most township schools could be another factor that is not giving teachers enough interactive ballast. Moreover, the chalkboard is not providing sound and visual features to support teaching and learning. This has left many Mathematics teachers frustrated and they continue teaching Mathematics in a less practical and overly abstract manner.

1.4 Problem statement

The GDE has responded to White paper call on e-education to "improve the quality of learning and teaching and deliver lifelong learning" by deploying technological resources such Interactive White

Boards (IWBs), laptops and tablets that accommodate different learning and teaching styles (White Paper on e-education, 2004, p.16). With ICT resources being made available to schools, access to resources is encouraged and teachers are expected to familiarise themselves with these resources. Their teaching approach is also expected to shift from teacher centred to learner centred (Islam, Sarker & Islam, 2022). The GDE's vision to equip grade 11 classrooms with IWBs is to provide technological access and assist in enhancing teaching and learning of curriculum content prior to learners' final year of study. With these technologies, teachers are required to facilitate learning and provide support which could enable learners to develop correct mathematical mental models and thinking skills (Ghory & Ghafory, 2021).

The current IWBs rollout requires Mathematics teachers to teach using correct technological pedagogical content knowledge. Mtshali (2021) explains that the multimodality of IWBs allows teachers to use different teaching methods that accommodate various learning styles. Studies have shown that affordances of IWBs are known to offer learners opportunity to actively interact with content and teachers, improvement in learner participation, communication and collaboration is notable in the classroom (Ndlovu, 2021). The affordances of IWB enable learners to process information in a creative, relaxed, and effortless manner (Ndlovu, 2021). The creative and constructive processing of information is also known to be directly linked to the positive learner achievement or performance. Furthermore, teachers' mediation of subject content through IWBs has been proven to offer learners prospects of exploring, sharing and reflecting their ideas in a classroom context (Humairoh, Heryatun & Hidayani, 2023).

Lack of knowledge or information about IWB's pedagogical affordances could result in teachers mediating content in an abstract and difficult manner (Mtshali, 2021). While GDE is also spending money in ensuring that Mathematics teachers in township schools have adequate resources, there is lack of evidence on whether teachers effectively use these resources to support teaching and learning in Mathematics classroom. In addition, the assumption that availing IWBs in South African township schools will bring a significant improvement in the teaching of Mathematics content is yet to be proven. What is noticeable is that Mathematics teachers are still battling with application of correct pedagogical approaches in IWB enhanced classrooms. Against this backdrop, this study investigates how teachers' preparedness and attitudes affect the effectiveness of integrating IWBs into teaching of grade 11 Mathematics content.

1.5 Research question

How do teachers' preparedness and attitudes affect the effectiveness of using the Multimodal Affordances of the Interactive Whiteboards into teaching of grade 11 Mathematics content?1.5.1 Sub-questions

The study aims to answer the following three sub questions:

1. What links do Mathematics teachers make between multimodal affordances of Interactive Whiteboards and the constructivist-oriented practices in the teaching of Mathematics concepts at Grade 11?
2. How do teachers' attitudes affect the integration of IWBs in the teaching of Mathematics content in Grade 11?
3. How do Grade 11 Mathematics teachers use IWBs' multimodal affordances to increase student–content, student–teacher, and student–student interaction in Mathematics classrooms?

1.6 Aims of the study

This study seeks to understand how teachers' preparedness affects the integration of IWBs as pedagogical tools in teaching of grade 11 Mathematics content. The study further aims to find out if there are any relations between their attitudes and the way in which IWBs are integrated in Mathematics lessons. Understanding how teachers use the multimodal affordances of IWBs to engage learners to teach Mathematics concepts is also crucial for this study. The intention is also to contribute to the ICT sphere by developing a framework which may be used to determine teachers' preparedness to integrate IWBs into Grade 11 Mathematics content.

1.7 Objectives of the study

The following objectives are derived to achieve the aim of the study:

1. To establish links that Mathematics teachers make between multimodal affordances of Interactive Whiteboards and the constructivist-oriented practices in the teaching of Mathematics concepts at Grade 11.
2. To investigate teachers' attitudes that advance the integration of IWBs in the teaching of Mathematics content in Grade 11.
3. To investigate ways in which Mathematics teachers at Grade 11 are using IWBs multimodal affordances to enhance their teaching and augment interactivity in the classroom.

1.8 Significance of the Study

The fourth industrial revolution requires a school curriculum that advocates usage of ICTs to mediate learning and teaching within the education system. The provisioning of IWBs within Gauteng township schools seeks to prepare teachers and learners with technical knowledge relevant to the 21st century. However, the challenge remains that teachers are not sufficiently trained to integrate IWBs into their Mathematics teaching and learning activities. Usage of such devices in the classroom has a huge transformational potential in the enhancement of learner engagement, but the unpreparedness of teachers to use IWBs and lack of Technological Pedagogical Content Knowledge (TPACK) around IWB could be a stumbling block. Even those with TPACK knowledge, it is difficult to identify if they are well prepared and have a positive attitude towards teaching with IWBs. However, there is little research investigating how IWBs promote deep mathematical knowledge development and understanding. Therefore, there is a need to develop understanding of the pedagogy associated with IWB in the teaching and learning of Mathematics at grade 11.

The presence of IWBs has unsettled Mathematics teachers' teaching approach and they are forced to review their traditional teaching approach. Therefore, this study aims to provide evidence about classroom practices that hinder effective usage of the IWBs to teach Mathematics. Moreover, the study seeks to give clear understanding of how teachers' preparedness and attitudes on IWBs affect how Mathematics content is delivered in a classroom.

Currently in South Africa, there is no clear framework which serves as a guideline on teachers' preparedness and attitudes towards IWB usage. The study has contributed to the ICT sphere by developing a framework which may be used to determine teachers' preparedness to integrate IWBs into Mathematics content and be used as a guide to teachers who may be new users of IWB. The findings of this study could assist the education department to evaluate teachers' competence and readiness towards the integration of IWBs into teaching of Mathematics content.

1.9 Theoretical lens of the study

The influence of users to adopt and adapt to technological tools is predominantly revolved around human behaviour and practices (Dai, Liu & Lim, 2023). As ICT evolved, human interaction with these resources changed significantly and the idea of models and theories started to emerge (Martinez-Marquez, 2021). These theories were developed to verify the effects of human behaviour towards technology usage and their contribution towards technology integration within the curriculum. Table 1 below gives reference to the history of theories and models of technology adoption and how factors of adoption were relevant for each theory. Although most theories are related to human behaviour and social factors, the Unified Theory of Adoption and Use of Technology (UTAUT) is considered as appropriate frameworks for the study. The UTAUT theory suits the study since it comprises four core factors of technology adoption which are performance expectancy, effort expectancy, social influence, and facilitating conditions. The UTAUT theory focuses on social practices, and it aligns with this study because teachers' preparedness and attitudes towards IWB usage can be regarded as behavioural actions embedded within humans. The UTAUT theory put emphasis on human which is in accordance with constructivist who argue for knowledge being socially constructed and that interactions help develop meaningful knowledge (Berger & Luckmann, 2023). Over and above the core factors, the UTAUT theory acknowledges the other four outcomes of the four core factors which also contribute towards technology usage. However, the theory regards the four core factors as main influencers of technology acceptance and use. These factors showed relevancy towards determining the preparedness and attitudes towards technology usage because they go beyond the TPACK knowledge to address internal and external social factors. A full description of the UTAUT model as a framework for the study is presented in chapter 3.

Table 1 The development stages of Technology Adoption Theories and Models

Theory/ Model Name	Year Developed/ Established	Developer	Factors of adoption
Diffusion of Innovation Theory	1960	Everett Roger	- Social system - Communication channels - Innovation
Theory of Reasoned Action (TRA)	1975	Ajzen and Fishbein	- Behavioural Intention - Attitude (A) - Subjective Norm
Technology Acceptance Model (TAM)	1985	Fred Davis	- Perceived usefulness - Perceived ease of use
Social Cognitive Theory (SCT)	1986	Bandura	- Affect - Anxiety
Technology Acceptance Model 2 (TAM2)	1989	Fred Davis	- Perceived usefulness - Perceived ease of use
Theory of Planned Behaviour (TPB)	1991	Ajzen	- Behavioural intention - Attitude (A) - Subjective Norm - Perceived Behavioural Control
The Model of PC Utilization (MPCU)	1991	Thompson, Higgins, and Howell.	- Job-fit - Complexity - Long-term consequences - Affect Towards Use - Social Factors - Facilitating Conditions
The Motivation Model (MM)	1992	Davis, Bagozzi, and Warshaw	- Extrinsic Motivation - Intrinsic Motivation
Combined TAM and TPB theory (C-TAM-TPB)	1995	Taylor and Todd	- Behavioural Intention - Attitude (A) - Subjective Norm - Perceived usefulness - Perceived ease of use
Extended TAM 2 Model	2000	Venkatesh and Davis	- Social Influence processes - Cognitive Instrumental processes
Unified Theory of Adoption and Use of Technology (UTAUT)	2003	Venkatesh, Morris, Davis, and Davis	- Performance expectancy - Effort expectancy - Social influence - Facilitating conditions: Age, gender, moderators, Experience, voluntariness of use

1.10 Summary of the chapter

This chapter presented the thesis's background by discussing the South African education system in relation to strategies implemented to address access and integration of ICT resources. The background showed how the Gauteng provincial government embarked on a program of provision of ICT resources to support teaching and learning in the classrooms. The status of e-learning showed how lessons continued to have mismatching pedagogies. The background also showed how the NDP prioritised Mathematics education because of its ability to develop critical thinking. This chapter showed a need to investigate teacher's preparedness and attitudes towards teaching with IWB, given that Mathematics performance continues to be poor even in the presence of new technologies. The problem statement, research questions, aims and objectives were clearly formulated to guide the study.

In the next chapter, the literature review gives an overview of teachers' preparedness and attitudes towards teaching with technologies such as IWB in Mathematics lessons. The study acknowledges how human's social aspects affect users' intentions to use technology.

Chapter 2 Literature review

2.1 Introduction

This chapter presents relevant literature from previous scholars, their findings, recommendation, and suggestions in accordance with the research topic. Concepts such as affordances of ICTs, Multimodal affordances of IWB, Pedagogical affordances of digital technologies, digital pedagogies, digital tendencies, perceptions about IWBs in Mathematics instructional environment together with preparedness and readiness to teach using IWBs have been discussed at great length. The last part of the chapter discusses the theoretical framework informing this study.

2.2. Affordances of ICTs in Mathematics classrooms

In trying to zoom into the technology in the educational setting, it is important to explain why ICTs and their affordances affect the education landscape. Studies have revealed the importance of resources having positive influence on the education outcomes. In fact, it has been discovered that South African schools high resource availability is linked to productive academic achievements (Mokgwathi, Graham & De Villiers, 2023). The affordance theory highlights the importance of organisms and an object complementing each other. It was developed and introduced in the late 1970s by Gibson and defined it as an association between a creature and an object, with the object perceived in relation to the needs of the creature (Hammond, 2023).

For Gibson, properties of an object remain unchanged, but opportunities of an object differ according to the needs of the organism. From Gibson's theory, the assumption in an ICT background is that properties of an ICT tool remain unchanged, but opportunities that the tool possess are perceived differently by individual users based on their needs. Gibson is of the view that affordances of an object are always in existence but ought to be perceived to be realised by the organism (Hammond, 2023). The ICT tool will remain irrelevant or unused for as long as the user (a teacher in this context) does not perceive its affordances. In the late eighties, Norman brought a different view of affordance he featured interaction of creatures and object into play (Moll, Dlamini, Ndlovu, Drennan, Nkambule & Phakathi, 2022). Norman sees culture and context playing an important role on the theory of affordance as compared to Gibson's theory, which is concerned about direct perceptual pick up of an affordance.

From Gibson's perspective, affordance of an object can be defined by using ecological approaches to explain human perceptions while Norman sees affordance as being focused on the relationship between people and object, their creative and adaptive interaction with the environment rather than any compliant response to any designed features of that environment (Moll et al., 2022). Gibson explains the affordance by focusing on the properties of the environment or an entity while Norman focuses on both the invariant properties of an object as well as the socially constructed perceptions and beliefs of the role players. The theory of affordances was highly dominated by two social constructivists Conole and Dyke in the early 2004. They gave an account of the affordance of information and communication technologies by building on Gibson and Norman's theory. They outlined a list of potential themes and instilled them into taxonomy of ICT affordance (Moll et al., 2022). It is importance to note the importance of these themes since they are in line with Mokgwathi, Graham and De Villiers (2023)'s view that relevant ICT resources could boast the teaching and learning of Mathematics curriculum. Therefore, is crucial to understand how accessibility, speed of change and other themes can enhance and distract technology adoption in Mathematics classrooms.

1. Accessibility

ICT offers easy access to vast amounts of information through portals and websites as well as via knowledge networks and shared communities of users. However, an exponential increase in the amount of information leads to issues of information overload and the need for more critical evaluation. This will require a change in the users' learning and information analysing skills. Accessing online learning tools that would make learning Mathematics to be practical and meaningful could lead to learners engaging with the subject content better. Access to mathematical programs on the IWB such as Geogebra could ensure that learners interact with content and manipulate information which could lead to acquisition of meaningful knowledge (Humble, 2022).

2. Speed of change

The speed of change may also mitigate against reflective and critical thought, fostering surface approaches to learning. The speed of change in a world full of conflicting and changing information is a challenge for the educational use of the new technologies. Students need to navigate their way through the myriads of changing information and make more informed decisions. Although, Mathematics does not change at the level of technologies, learners should take advantage of technologies that bring versatility, interaction and multimodality.

3. Diversity

ICT offers access to a vast range of diverse and different experiences that can inform learning such as overseas websites, access to Mathematics experts, or use of simulations to replicate complex behaviour. Information technologies provide a means by which learners can be exposed to experiences very different to their own and extend their mathematics horizon beyond their own communities.

4. Communication and collaboration

New technologies have opened the possibility of new forms of dialogue and communication. ICT offers the potential to develop new forms of online communities and new means of communicating and sharing information; from signing up to mailing lists through, to being involved in specialized discussion forums and chat rooms. A technology which could allow Mathematics learners to engage and challenge each other's thoughts would spark self-reflection and self-determination.

5. Reflection

ICT has the potential to enable reflection and criticality to be enhanced. There is a risk that the speed and pace of information change outlined above militates against reflection. It leaves no space for contemplation and considered judgement, and promotes a more pragmatic, reflexive immediate response to new information.

6. Multimodal and non-linear

ICT enables Mathematics learners to move beyond linear pathways of learning, characteristic of, but not exclusive to behaviourist approaches, and to adopt more individualized strategies and pathways. Affordance of ICT is the potential for multi-modal and non-linear approaches to learning. The multimodal feature of ICT, bring more opportunities for learners with different learning styles especially in abstract subjects like Mathematics.

7. Risk, fragility, and uncertainty

There is an intrinsic level of fragility in digital technologies and networks. These complex systems are vulnerable to abuses, to disruption from viruses and SPAM, or simply to the servers 'being down'. The increased use of technologies by different groups of users often gives rise to unintended consequences. For example, the increase in the volume of information available on the web has led to new forms of plagiarism. There are risks and levels of uncertainty associated with a dependence and reliance on the instantaneous provision of information and communication.

As Mathematics teachers use IWB to teach, they use their experience to make meaningful teaching through these technologies. This is in line with Hammond's (2023) perceptions that new technologies are best understood through past use of similar technologies. And Hammond (2023) further clarifies that if teachers are unable to directly perceive ICT affordances, they are unlikely to be an enthusiastic adopter those ICTS. It is for this reason that Norman (1988) suggests that there is a very close relationship between user's past knowledge and experience and how cognitive and perceptions are influenced by that knowledge and experience.

Teachers' ICT perception and experience clearly has an influence on how Mathematics content will be mediated together with teaching strategy to be used. Studies suggest that teachers' prior ICT experiences shape how they integrate IWBs into Mathematics pedagogy. Although ICT devices will remain unused until they are well perceived, the challenge is that there is no guarantee that those who perceive the affordances of ICTs will eventually use them. Another challenge is that positive perceptions guarantee does not equate to readiness or preparedness to use the ICT concerned. However, the multimodal affordances of IWB can't be neglected because the readiness of teachers to use a technology rest on the knowledge and skills of using these resources.

2.3 Multimodal affordances of IWB in Mathematics classrooms

The educational instructions are designed around resources suitable to mediate teaching and learning in the classroom. Various educational technologies are becoming inseparable from the school curriculum. As technology evolved, developed countries where resources such as traditional blackboards are used in minimal state, they became irrelevant and redundant. The traditional blackboards do not keep up to speed with the educational expectations especially in subjects where abstract content is expected to be simplified and presented in various modes like Mathematics. The IWBs which have multimodal capacity to facilitate learning are bringing a huge impact on content mediation and conceptualisation (Divya, 2023). These multimodal features include shapes, images in different dimensions (2D, 3D, etc), colours, embedded objects which can be manipulated (rotation, flipped, twisted, etc), sound and videos capable of enhancing instructional designs (Divya, 2023). Samsonova, (2021) sees IWB as educational tools capable of presenting information in different modes which can provide graphics, investigations, and kinaesthetic activities. These multimodal affordances of IWB offer a range of educational opportunities which assist in shaping teaching and learning environments.

Studies have shown that most teachers use IWBs as chalkboard or blackboard and they are failing to harness the multimodality of IWBs to produce meaningful content (Divya, 2023). The study acknowledges this gap and seeks to understand factors which could be contributing to poor usage. Other researchers have noted the commitment by few teachers who take advantage of IWB's flexibility to manage and create class activities that stimulate learners' interest (Bourbour, 2023). Of course, this is achieved through connecting the multimodality features of the IWB together with correct pedagogies that suit the learning environment. The same findings were noted by Bourbour (2023) that the features of the hardware cannot dictate learning. The effective way of using IWB in a Mathematics lesson is not innate to the technology of the content it carries, the teaching strategies which is aligned to the IWB is much important (Bourbour, 2023).

The flexibility and multimodalities which come with IWBs afford teachers opportunities to create stimulating activities that appeal to learners' interests. Class activities that are interactive and created from different modes encourage active participation, discussions, communication, and collaboration amongst learners (Müller & Wachter, 2022). Interaction amongst learners and teachers is realised through activities that are modified to suit learner centred teaching approaches. Learners acquire knowledge which is meaningful and relevant to their social context as they interact with challenging class activities. The interactive activities designed on the IWBs enable learners to have a practical experience where they physically manipulate objects by rotating, flipping and moving them. Learners gain experience by touching, moving models and objects which help them to reshape their mental models of scientific concepts (Müller & Wachter, 2022).

The opportunities that come with multimodality of IWBs require adequate knowledge and skills to teach in accordance with modes relevant for the learning concepts. Multimodalities alone will not automatically transform the learning environment without teachers' intervention. Teachers should be developed gradually to acquire knowledge which matches the modes and the purpose of the task (Divya, 2023). When relevant knowledge is acquired correctly, and modes are matched with correct methodologies, teachers' classroom practices should reflect attributes of enquiry-based learning. For Samsonova, (2021) teachers have a responsibility of mediating content through multimodal resources to make the learning environment to be conducive and active for learning. Learners are supported through multimodal affordances of IWB, and they eventually become exposed to learning opportunities which improve their human development (Samsonova, 2021). Although multimodal affordances of IWB are important for classroom context, teachers must complement these technological tools with pedagogics that suits their teaching style. Digital devices must be accompanied by digital pedagogies that align with classroom context.

2.4 Pedagogical affordances of digital technologies in Mathematics classrooms

IWBs are one of the ICT cognitive tools that are gradually introduced in the classrooms. Based on Lewis (2021), ICTs are education tools which come in many forms, software and hardware and they influence our interaction with the world. Teachers don't acquire skills and knowledge of using available technologies in their classroom by default, they require pre-knowledge or training. From Dlamini's (2023) point of ICT, teachers require formal training on the use of ICT as a pedagogical tool to master the pedagogical affordances of the ICT. Knowing ICT for what it can do alone is not enough, the pedagogic opportunities of the ICT are more important than the ICT tool itself.

While ICT affordances may support curriculum delivery, their impact depends on teachers' pedagogical integration, and this remains a challenge to South African township schools. For Aytar (2023) ICTs does not automatically transfer pedagogical affordances in a classroom, learning is centred around learning tools, learners and mediation strategies which suit the tools concerned. Although IWBs offer affordances, research highlights inconsistent teacher integration, particularly in Mathematics classrooms, which raises questions about their actual contribution to learning (Dube, 2024). It is the responsibility of teachers to ensure that the IWBs are correctly integrated within the school curriculum as these will extend learners' knowledge capacity and transform teaching and learning through IWB affordances.

IWBs are known to provide pedagogical benefits in the classroom for both teachers and learners. These IWB activities are known to be promoting tasks authenticity and connectedness especially if content is accessed online (Divya, 2023). Learners are exposed to real situations through simulations and concepts are explored through the virtual world. Real life actions through virtual demonstrations bring about active classroom participation and stimulate learning interest. Through activity-based lessons which encourage open discussions, learners' communication skills are improved. Different learning and teaching styles are addressed through IWB's multimodality and versatility (Divya, 2023). In an IWB enabled classroom, learners' attention and participation is evident since they become highly engaged with activities that require them to focus on audio visuals. The flexibility of teaching with IWBs enables teachers to plan, prepare and teach content that is frequently revisited for review and upgrade (Kühl & Wohninsland, 2022). Previous lessons can be taught for further explanations and reinforcing purposes.

Pedagogical affordances of IWB enable vast acceleration of collaborative learning and adoption of different teaching styles, learners learn to work together and independently from the teacher. Teaching becomes learner oriented, and the teacher's cognitive load is lessened since learners take charge of their learning space. Individual attention is given since open discussions are evident in IWB classrooms. The incorporation of IWB together with adequate pedagogies stimulates cognitive development of the learner, through high content-learner and teacher interactivity (Alharbi & Khalil, 2022).

2.5 Digital pedagogies in Mathematics classrooms

Sun, Chen, and Ruokamo (2021) mention that digital pedagogies have abilities to address classroom practices that are not catering for different learning styles. Digital pedagogy is more concerned with finding out how to teach with digital technologies (Sun, Chen & Ruokamo, 2021). Teachers' ought to keep up with new teaching approaches that incorporate technology. Aljović (2023) reveals that effective teaching occurs when teachers become digital natives and apply a teaching approach that is technology driven. This means that teachers know and understand the digital language and how learners learn through digital tools. Embedding digital pedagogies in classrooms give learners opportunities to overcome global expectations which require 21st century skills and knowledge economy.

Clarke and Clarke (2009) highlight that sometimes learning becomes passive because of the disconnection between how learners learn and the way in which teachers teach. This disjuncture emanates from teachers migrating from the old teaching approach to a digital pedagogical approach which seeks to match the current digital natives. Clarke and Clarke (2009) call for a pedagogy that must focus on students' learning style and teaching approach which seeks to address learners' needs. Most teachers are unable to apply a teaching methodology that is appealing to learners because they are still stuck in a teacher dominant approach which has less emphasis on learner engagement. For learning to be meaningful, teachers are forced to relate curriculum in a language and style that suits learners (Clarke & Clarke, 2009). The concern about the old pedagogical approach is that it does not suit learners' social reality, especially those who are born with technology.

Introduction of digital technologies in classrooms can bring about complexities in teaching and learning and requires teachers to adopt and adapt to a pedagogical approach that suits a diverse classroom context. Teaching through digital technologies can be disruptive especially if teachers are not applying the correct pedagogical approach. For Kara (2021), digital integration in the classroom requires teachers to understand Technological Pedagogical Content Knowledge (TPCK) which relates to the art of using technology to teach a specific content. Teachers should have adequate pedagogical understanding on how digital technologies can be integrated in ways that support interactive learning (Kara, 2021). As teachers try to implement their instructional strategies, they should be aware of the disruptive or addictiveness of the technology so that they can avoid applying a disruptive digital pedagogy in trying to integrate the technology in their classroom context (Kara, 2021).

2.6 Digital tendencies and Mathematics teaching and learning

This section covers both international and local digital tendencies in Mathematics classrooms. It compares how international countries harness the affordances of IWB to enhance teaching of Mathematics content against South African context. While prior studies examined IWBs broadly, few explore how their multimodal affordances are integrated in Mathematics lessons in township schools. It goes further to show gaps within South African education system in trying to adopt IWB as a pedagogical tool towards teaching of Mathematics content.

2.6.1 International digital tendencies and Mathematics teaching

The technological change across the world has infiltrated the education system and has brought many dynamics in the classrooms (Wang, Chen, Yu, Liu & Jing, 2024). Contemporary learning and teaching practices through digital technologies are being advocated in the education space. The influence of these digital technologies in education is gradually transforming the education fraternity across the globe. The transformation seeks to make learners remain relevant citizens in future by giving them education that makes them ready for global citizenship. Khalil and Alnatheer (2020) acknowledge Mathematics content as being useful and capable of developing learners' thinking abilities. However, they also take into consideration that technology-based education seeks to prepare learners to compete at the global stage.

Digital technologies are known to develop learners' critical and logical thinking, improve communication skills, solve problems, work independently and in collaboration with others (Wang et al., 2024).
Khalil and Alnatheer (2020) insist that we cannot wait any longer to incorporate digital technology in the classrooms. They are of the view that we are in the knowledge era, regardless of our readiness. Based on Ng, Lee, Tan, Hu, Downie and Chu (2023), the United Nations Educational, Scientific and Cultural

Organization (UNESCO) in 2021 has reported that “eleven countries around the world have incorporated AI into their STEM/computing curricula to promote competitiveness and equip young people for the future workplace” (p 3). The adoption of digital tools in classrooms is at the highest speed especially in developed countries. Trilling and Fadel (2009) caution us to be not left behind because with todays and tomorrow’s digital tools, our next generation of students will have unprecedented power to amplify their ability to think, learn, communicate, collaborate, and create. In the 21st century, everyone’s level of information literacy and fluency will need to rise” (p 61-65). Teachers are therefore compelled to adopt digital pedagogies to remain relevant to the digital natives (Wang, Chen et al., 2024). This is also supported by Khalil and Alnatheer (2020) who are of the view that teachers who use digital technologies will enable learners an opportunity to collaborate, learn and participate in the technology society.

Wang et al., (2024) explain that there is a demand for teachers to change their pedagogies to keep pace with the ever-changing digital world. The ubiquitous computing in education dictates for pedagogies that encourage active learning rather than passive learning consumption. To realize an active learning environment, schools should seek to change the teaching approach to deal with the increasing complexities of educational technologies that are penetrating the classrooms (Wang et al., 2024). The digital affordances coupled with a learning paradigm that focuses on knowledge construction and digital pedagogical knowledge have higher possibilities of transforming the education system to remain relevant to the industrial age. The Australian government, for example, has hit a call to transform education by summoning teachers to use resources, activities and digital pedagogies to implement a digitised curriculum (Arantes, 2024). On the other hand, digital trends can be traced from American education which also advocates for digital pedagogies (Göçen & Duman, 2021). Digital technologies influence content delivery in a manner that learners learn by inquiring knowledge through research (Göçen & Duman, 2021). From a South African education context, more work needs to be done to keep up with the global digital tendencies.

Research shows that the UK, Australia and New Zealand are amongst countries that have highly adopted ICTs in the classroom. African countries are still trying to establish themselves with regards to ICT usage and integration (Faturoti, 2022). Uganda, Kenya, and South Africa are amongst African countries that are closing the access gap in terms of ICT. Although the provisioning of ICTs is at the centre of priorities, e-Content development and capacity building amongst these countries seem to be lacking (Faturoti, 2022). Low ICT skills, especially for teachers, seem to be a common challenge to most countries. The use of IWB in Mathematics classrooms across the world is gradually improving. In narrowing the access gap and integration of ICTs, IWB has gradually managed to penetrate European countries and by now, more of these countries have IWBs in the classrooms (Erdener, 2021). The United States, Asian countries and other developed countries are catching up with regards to IWB usage in the classroom. The affordances of IWB have attracted teachers to teach with these technological tools daily. However, more development must be done to ensure that these teachers are ready to correctly integrate IWBs into the school curriculum especially in the context of South Africa.

2.6.2 South African digital tendencies and Mathematics teaching

The South African's white paper on education policy gives clear guidelines on ICT implementation, however, it finds itself at disarray with teachers' readiness and maturity in ICT. The adoption of interactive whiteboards into classroom teaching has been widespread across South African schools. However, integration of these resources into school curriculum continued to be a challenge for most teachers. Western Cape Province is amongst the first provinces to roll out IWBs in a few public schools (Kock, 2022). Eastern Cape joined the initiative by partnering with private and public institutions to deploy interactive boards such as e-Beams. In the past five years, Gauteng Department of Education (GDE) started provisioning IWBs to the disadvantaged township schools. More provinces seem to be learning from the GDE's Paperless Classroom programme targeting mainly public township schools where there are contextual factors ranging from theft, poor usage, poor management of resources, just to mention a few.

With most South African township schools still exploring and adopting IWBs, the research shows that most teachers still find it difficult to incorporate these technologies into their lessons (Kock, 2022). The training provided to these teachers was found to be inadequate if not enough to integrate the IWBs into the school curriculum and their confidence to teach with IWB dropped (Kock, 2022). Poor ICT skills for teachers have been noted to be the biggest challenge towards IWB integration. Even those with ICT skills and knowledge about IWBs, were found struggling when they teach because they have not developed confidence in teaching with these resources (Kock, 2022). On the other hand, Samsonova (2021) suggests that teacher interest to teach with IWBs has been noticed to be high, although they lacked appropriate teaching strategies that were suitable for classroom digital resources. There is no smooth transition from a projector to IWB usage in a manner that basic ICT skills are mastered before full multimodalities of IWBs can be explored (Samsonova, 2021). Evidence can be drawn from lack of developing interactive activities that engage learners' thinking.

Studies have found the inability to access ICT resources having linked to poor achievements in mathematics lessons (Lebone, 2022). Teachers' ICT limitations have direct impact on the content delivery of Mathematics content. Such teachers are deemed to be lacking digital pedagogies needed for Mathematics integration (Mokoena & Simelane-Mnisi, 2024). Although there is quite a vast difference in how IWB are used in township schools, studies have shown how teachers fumble to adopt different teaching strategies to enhance their lessons. Some teachers from township schools seems to be lacking technical pedagogical skills relevant for their subjects. Hence Mathematics results in FET phase keeps on dropping throughout the years.

In schools where IWBs are used for teaching, Samsonova (2021) found out that most teachers are comfortable users of the boards, but they use it as a chalkboard. The multimodality that the IWB possesses, and its pedagogical affordances are less explored. For the past few years in schools where IWBs are used for teaching, less progress has been noticed in terms of ICT integration (Samsonova, 2021). The slow progress cannot be equated to lack of access to IWBs, there are quite several factors which might be associated with (Kock, 2022). More studies ought to be done to investigate how these factors contribute towards IWB integration.

For Finkelstein, Wu and Brennan-Ing (2023), knowledge about an ICT or an ICT skill is not enough to guarantee usage of the resource. Constant usage of IWB, frequent development and on-site support might be a solution for poor IWB integration. Kock (2022) recommended that in needy provinces such as Eastern Cape, rolling out e-Beams on a large scale might be a disaster, especially that the province is dominated by rural schools where teacher and learner ICT skills are very low. Kock (2022) further recommends that the education ministry should gradually roll out ICT programmes in a more structured and systematic manner since these resources have opportunities to transform the education system to be more meaningful and productive. With Gauteng and Western Cape leading other provinces in terms of infrastructure, budget, etc, it would be interesting to see how these provinces could roll out IWBs on a larger scale. Rolling out IWB on a large scale means that teachers should adopt and adapt to a new way of teaching with technology. Equipping classrooms with IWB requires teachers to have relevant knowledge about technology and appropriate teaching approaches for technology at hand. Their preparedness to use IWBs will be reflected in their classroom practices as they interact with learners, subject content and technology. Despite provision of IWBs in Gauteng township schools, little is known about how Grade 11 Mathematics teachers use IWB's multimodal affordances during lessons. And this brings us to the next section where knowledge required to use the IWB to teach (TPACK) Mathematics is discussed.

2.7 Knowledge required to use IWB to teach (TPACK) Mathematics

Before technology could sink through the education system, teaching practice was recognised and referred to as a discipline consisting of content and pedagogical knowledge (Kartal & Çınar, 2024). The integration of these sets of knowledge constituted a teaching profession which without any doubt, made a huge impact on learners' lives and society in general. When technology was introduced in the education system, teachers were compelled to adopt the new technological knowledge since curriculum delivery needed to be mediated through these technologies. Technological knowledge was then conceived to be another set of knowledge which must be embedded within other sets of knowledge (Kartal & Çınar, 2024).

Kartal and Çınar (2024) recommend that teachers should possess the integrated sets of knowledge named Technological Pedagogical Content Knowledge (TPACK). For those that don't possess this knowledge, they should continue developing TPACK through the ICT instructional process. The process must unfold in three phases: fostering teachers' acceptance and technical proficiency; pedagogical modelling and pedagogical application (Kartal & Çınar, 2024). Teachers will start to accept the use of IWB when they see the importance and benefits of IWBs in the classroom. An instructional strategy that encourages the use of IWBs should be practised to boast their experience around IWBs. When teachers observe a systematic, structured and content-based way of using IWBs, they are likely to become well prepared and ready to use them. After teachers observe how IWBs are used, they should mimic the way IWBs were demonstrated eventually, they will develop pedagogic practices to support IWB integration within the curriculum (Kartal & Çınar, 2024). Teachers who can make connections between subject content and pedagogical knowledge, their TPACK application is not seen as an add-on.

Kartal and Çınar (2024) summarise the TPACK model as comprising of three first layer of knowledge:

1. Technological Knowledge (TK) – knowledge of technology (for this research technology would be IWB).
2. Pedagogical Knowledge (PK) – teaching methodology knowledge (the art of teaching Mathematics).
3. Content Knowledge (CK) –subject content knowledge (Mathematics content knowledge).

Kartal and Çınar (2024) further provide four (4) other important sets of knowledge derived from interconnection of the first three set of knowledge and they are outlined as follows:

1. Technological Content Knowledge (TCK) — interconnection between technology and Mathematics. The two could reinforce or constrain each other.
2. Technological Pedagogical Knowledge (TPK) — knowledge of using technology to implement different teaching methods (Koh & Divaharan, 2011).
3. Pedagogical Content Knowledge (PCK) — knowledge of how teachers interpret the subject matter.

4. Technological Pedagogical Content Knowledge (TPACK) — knowledge of using available technological resources to teach subject content using appropriate teaching methods. Mathematics teachers would align their pedagogical practices to ensure that specific Mathematics technologies benefit learners and improve their learning experiences. The TPACK figure 1 below gives a structural representation of seven sets of knowledge as depicted by Koh and Divaharan (2011).

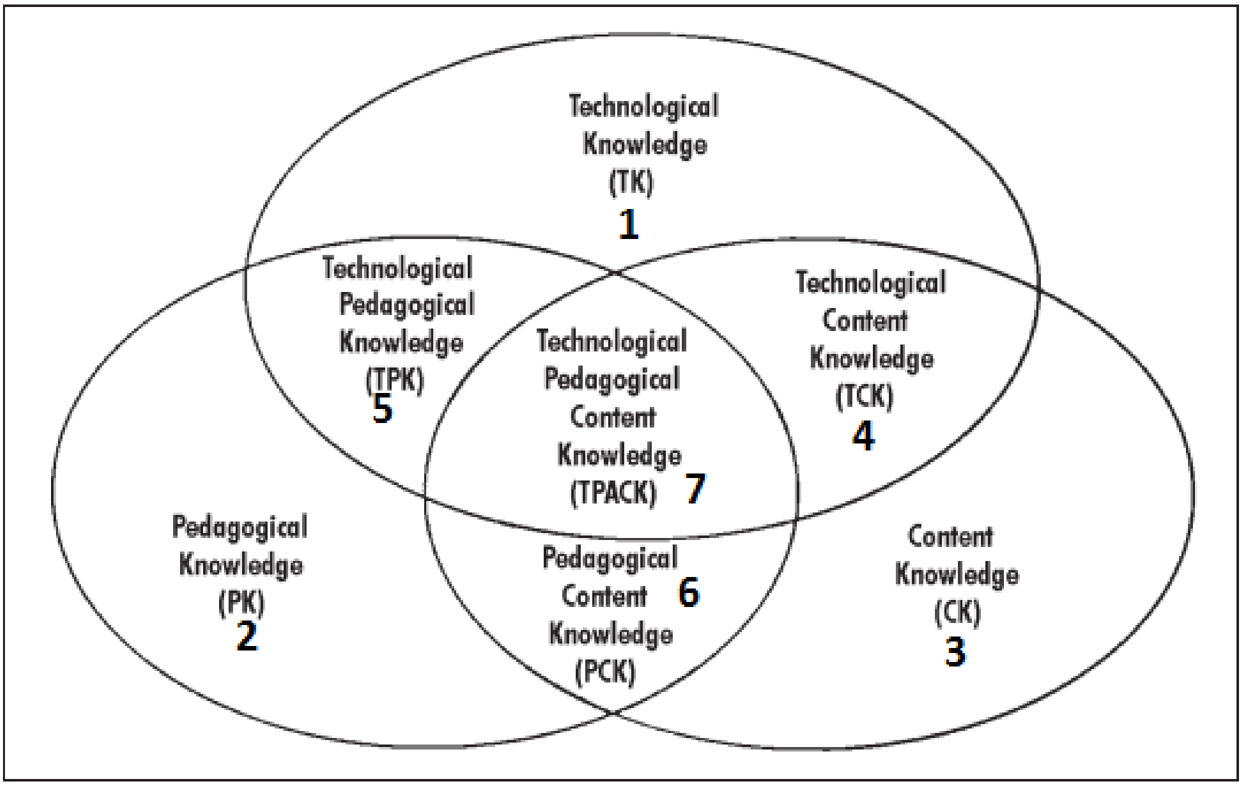

Figure 1 TPACK framework

Based on Kartal and Çınar (2024), to fully develop teachers to have technological pedagogical content knowledge, they should first accept the new technologies through a modelling process. Through adopting and modelling these ICTs such as IWBs, teachers' technological knowledge, pedagogical knowledge, and content knowledge will eventually be strengthened. Teachers often become reluctant to use new technologies to teach even if the technology has more affordances. In classrooms where IWBs are used to deliver content and support teaching, individual learner needs tend to be addressed (Serajuddin, 2023). However, achieving those needs is dependent on the way in which teachers carry out instructions and mediate learning through these technologies (Mayer, 2021). IWBs are amongst technologies that when they are not used properly in class, they can be disruptive. Teachers therefore need to be ready and prepared to deal with these technologies in a manner that will enhance teaching and learning in the classroom. Introducing IWB as a classroom innovation should connect with the pedagogy to transform learning and teaching (Maryam, Sören & Gunilla, 2020). If that is not the case, then the technology serves no purpose to learning. Technology integration must be adapted gradually into the lesson; teachers ought to develop new ways of integrating IWBs to produce teaching strategies that are relevant to the learning activities (Mayer, 2021).

A teacher is deemed to be ready and prepared to use the IWB when he/she can use IWB software to interact with content which will eventually encourage interaction and social cohesion (Maryam, Sören and Gunilla, 2020). Access to content from various platforms including gallery and internet, manipulation of information and linking multimedia content can be regarded as being prepared to use the board to mediate learning. Developing interactive activities that encourage collaboration and improve learner performance indicates effective usage of IWB by teachers (Tanjung, 2022). Mathematics teachers who can develop these activities could witness learner centred lessons where learners take ownership of the lesson. Learner participation could be highly achieved, and this might boast learner interest in attempting to Mathematics sums.

Studies have shown that when IWBs are pedagogically integrated within the lesson, the presentations are likely to improve learner concentration, engagement, and motivation level. The effectiveness of IWBs use is dependent on the classroom practices and instructional methodology used to enhance teacher-learners, learner-learner, and learner-content interaction. Maryam, Sören and Gunilla (2020), recognise IWB as a technology tool which teachers should strategically use to promote dialogue amongst teachers and learners. Elevation of teachers' confidence level on IWB usage boosts their attitude towards IWB usage. For teachers to be deemed ready to work with IWBs, they ought to create lessons which are learner-centred and focus on inquiry and active learning (Samsonova, 2021). Their lesson objectives should focus on building knowledge which revolves around both teachers and learners rather than depending on teachers as a source of knowledge.

The TPACK framework emphasises the importance of acquiring adequate knowledge in preparation for technology usage. However, knowledge about technologies and pedagogies is not enough for teachers to be deemed ready to use technology (Al-Adwan, Al-Adwan, Abbasi, Albelbisi & Habibi, 2023). Other factors such as attitude, experience of teaching with ICTs and intentions to use technology are important towards teacher preparedness to use technology. The TPACK framework shows gaps in relation to teacher preparedness to use technology since it does not recognise social factors. The interactivity theorem puts its emphasis on social factors that promotes interaction amongst teachers, learners and subject content. This aspect is briefly discussed in the next section.

2.8 Interactive Equivalency Theorem

Terry Anderson used the interactive concept to develop an interactive equivalency theorem which shows how learning is comprehended in a social setup (Miyazoe & Anderson, 2010). The theorem puts emphasis on how learning is conceived through interactivity. It suggests that meaningful learning occurs provided one of these interactions takes place; student–teacher or student-student or student-content interaction. The most effective learning experience will be experienced when these three interactions at its highest level (Miyazoe & Anderson, 2013). High effective interaction brings more opportunities for learning and knowledge reflection. The nature of educational instructions will give shape to the kind of interaction one will experience in a classroom. Moreover, a learner can still maintain effective educational experience even if interaction mode is switched (Miyazoe & Anderson, 2013). This suggests that teachers as instructors ought to be flexible in their approach and present situations where interaction may change without compromising the educational opportunities.

The nature of interactivity in a learning context is informed by the instructional setup aimed at producing meaningful learning. The interactivity equivalency theorem is therefore relevant in helping us establish how the multimodal affordances of IWB are used to enhance teaching and augment interactivity in the classroom. IWB is known to offer kinaesthetic affordances which present a variety of learning and teaching prospects (Ebrahim, 2022). However, the teacher's instructional approach plays an important role in promoting effective interaction especially where technology is used to mediate learning. A shift from a didactic to an experiential approach could maximise interaction of content through technologies and improve collaboration amongst learners. Interactive teaching could facilitate dialogue which may improve communication and collaboration. Learners' independence from the instructor could be realised by facilitating learner-content interaction while support and reinforcement of learner's knowledge could be realised when there is learner-teacher interaction. Collaboration and discovery learning amongst learners can be achieved through learner-learner interaction (Miyazoe & Anderson, 2013).

The interaction process and classroom instructional design are entirely dependent on the tools and classroom context. The IWB is one of the technological tools that afford users, interactive affordances.

Depending on how IWB are used or perceived, they have potential in creating a conducive and productive learning experience. Ebrahim (2022) suggests that teachers ought to take advantage of IWB's interactivity. If not, their teaching will be less effective. The interactivity of the board compliments the new digital pedagogical approaches and promotes active learning experience.

The interactivity equivalency theorem relates well with the constructivist approach because they both see learning as a phenomenon resulting from social interaction. The learner-content, learner-learner, and learner-instructor interaction explain how learners get to conceptualise knowledge through interacting with the outside world (Duttlinger, 2021). Constructivists regard learners as active knowledge creators, and they do not believe that knowledge can be passively received. Knowledge is constructed through internalising, negotiating and sharing information (Duttlinger, 2021). Through interaction, learners are presumed to build and modify knowledge which could be used to solve real time problems. Learners' interactivity encourages learning through doing and hands-on practices (Chen & Hwang, 2019). Interactive teaching through IWB facilitates quicker conceptualisation of knowledge since content is presented through visuals, audio, and text. The multimedia content that IWB possesses, and its interactivity makes it easier for learners to compare content in various forms. However, Luo et al. (2023) caution IWB users not to limit their knowledge of interactivity to that of the IWB, but to go beyond and explore how the IWB can help them promote high learner participation and communication in class.

The below figure 2 is derived from Moore (1993) and it summarises the interaction between the learner, teacher and content.

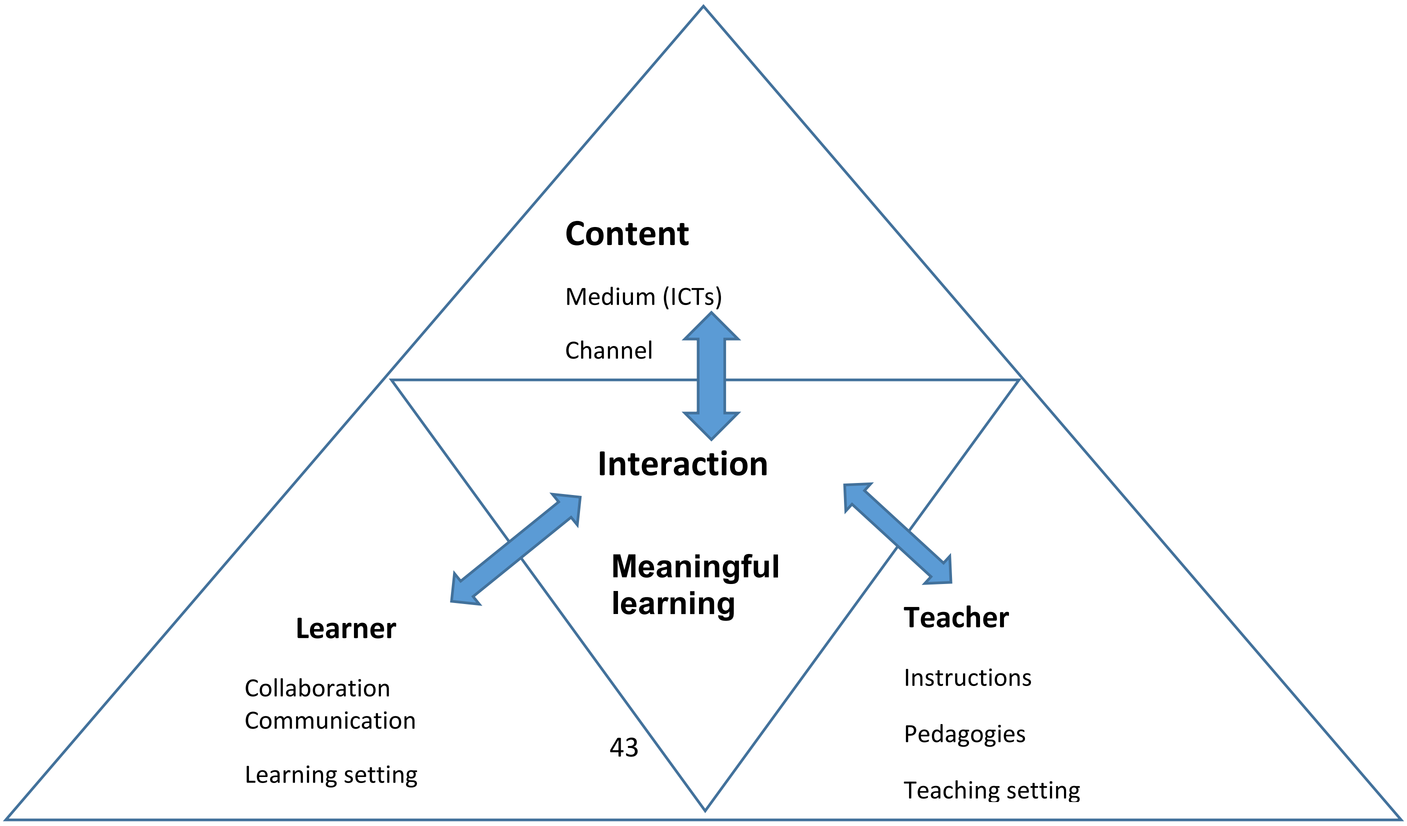

Figure 2 Interaction between Learner, Teacher, and Content

The theory of interactivity has long dominated the education cycle; with theorists like Moore (1993) zooming into teachers' pedagogical practices in IWB enabled classrooms. Applying correct pedagogies that promote collaborative practices and adequate integration of content through IWB could possibly bring about high interaction which produces meaningful learning. The existence of IWB in the classroom is not enough to raise the level of interactivity, applying instructions that promote learner-centred approach could improve classroom interaction (Samsonova, 2021). Teachers must therefore adopt teaching strategies that are aligned to the learning context and IWB affordances.

As we continue exploring how IWB contributes towards bringing effective interaction in the classroom, theorists went further to check if IWB brings change to the pedagogical practices of educators. Kunya and Adamu (2021) cite the report by BECTA (2008) which shows no evidence on the pedagogical change for ICT users. This is supported by Samsonova (2021) who believes that IWB brings technical opportunities which contribute less to the teaching and learning method and as such, they cannot solve pedagogical problems. However, other theorists believe IWB improves teachers' confidence, and pedagogical skills are acquired over time as interaction becomes intense (TP & MINH, 2021). IWBs bring about a change of pedagogical practice in the classroom because they enable teachers to plan and prepare comprehensible lessons through a variety of creative options (TP & MINH, 2021). Based on whether IWB brings change to the pedagogical practices of educators, this study aligns itself with the view of TP and MINH (2021) that technology (IWB) has a potential in assisting with classroom interaction, but instructional method still lies in the hands of the educator.

2.9 Perceptions about IWBs in Mathematics instructional environment

Teachers' perception around IWBs usage differs tremendously from one teacher to another. Research around teachers' perception on the IWB usage mainly focused on various aspects such as attitudes, motivation, satisfaction, interaction, acceptances and technical issues of IWB use (Erdener, 2021). It is argued that teachers who have reached e-Maturity in terms of IWB usage and are effective users of technology are likely to have a better perception than those who have not done so yet. Teachers' understanding of IWB usage perceptions and effective instructional use of IWB requires teachers who can apply appropriate digital teaching strategies taking cognisance of learning context and learners' needs (Luo, Tan, He & Wu, 2023). Moreover, even if teachers may have IWB skills and knowledge, understanding of pedagogical implications for effective teaching is of utmost importance (Luo, et al., 2023). There is a correlation between increasing the use of technology to teacher acceptance and positive attitude towards technology (Luo et al., 2023). The frequent use of IWB is also seen to be having an impact on teachers' IWB usage perception.

Studies revealed that Mathematics teachers have developed high competency and positive attitudes towards IWB usage because of the time they spent using the boards (Luo et al., 2023). Erdener (2021) encourages the frequent use of IWB as it has a potential of improving IWB integration, developing positive interest towards IWB usage, acceptance of IWB and effective use of the technology. A continuous teacher training that aims at improving and maintaining digital skills and pedagogies have high potential in transforming teachers' perceptions around IWB usage. Once they have developed positive perceptions around IWB, their pedagogies are more likely to accommodate learners' interests and promote more interaction.

Teachers' practices cannot be separated from their perceptions. Their sets of beliefs govern how they perceive and interact with digital teaching tools to mediate learning in the classrooms. Their teaching experience through ICTs is more likely to influence the pedagogic strategy that they will use in the classroom since their classroom practices are directly inspired by their pedagogical perceptions (Erdener, 2021). Narrowing ICTs access is not enough to bridge the usage level in the classroom, what is of paramount important is teachers' ICT adoption, teachers' perceptions and beliefs about ICT resources dictate the success and failure of ICT usage. Some teachers have access to ICTs but the fact that they might not perceive them useful for teaching, most ICTs will be left unused.

The research by Hart (2023) which was based on factors impacting the uptake of educational technology in the classroom used the Unified Theory of Acceptance and Use of Technology (UTAUT) model produced by Venkatesh, Morris, Davis and Davis (2003) to explain teachers' behavioural patterns in a technological space. Hart (2023) clarified the UTAUT model to explain four behavioural aspects which influence teachers' willingness to use technology. The four main (4) behavioural aspects were identified as follows; performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). The intentions to use technology is informed by teacher's perception on how helpful, easy or difficult the technology is and understanding of the technology in a social context towards benefiting them (Hart, 2023). Figure 3 shows teachers' expectancies versus intentions to use technology.

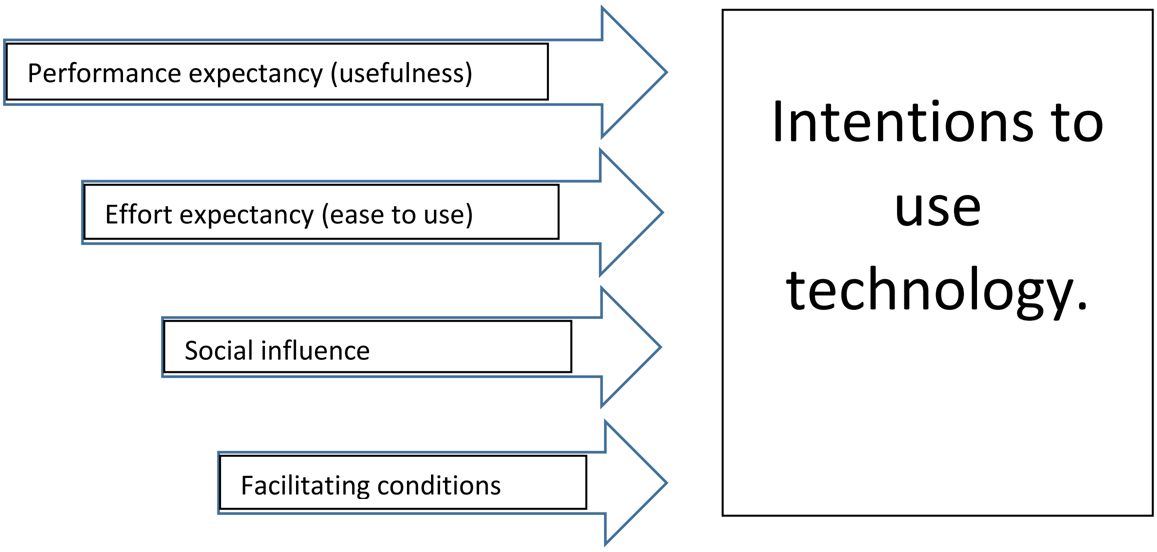

Figure 3 Unified theory of acceptance and use of technology (UTAUT)

The four main aspects of the UTAUT model explain the behavioural expectation of teachers in terms of utilising technology to improve teaching and learning. According to Gonzales and Gonzales (2021), many teachers perceive IWBs as tools which could foster interaction and increase learning experience. Although teachers have positive perception about IWB, evidence shows that in schools where ICT skills are very low, teachers use IWB as a chalkboard, overhead projectors and white boards to write notes (Gonzales & Gonzales, 2021). In schools where teachers have ICT skills, they have potential of witnessing the positive pedagogical attributes of IWB through engaging with experienced IWB users. Moreover, their perceptions around IWB are bound to change because they shall have seen the way in which experienced users prepare, deliver lessons and assess learners through IWBs. Even though the UTAUT model explains the expectation of using general education technologies, the research sees the UTAUT relevant to gauge teachers' perceptions about IWBs in Mathematics instructional environment since IWBs are part of educational technologies used in many curricula (Gonzales & Gonzales, 2021).

The UTAUT theory puts human perception and social influence as aspects influencing intentions to use technology. However, ICT knowledge and experience play a vital role in contributing to technology integration. The aspiration to use an ICT tool exists on the basis that the tool should make teaching more exciting (Aytar, 2023). Teachers' technology usage is also affected by the expectation of getting assistance from organisational structures to improve their intentions to use technology. The framework also gives account of teachers' behavioural intentions towards technology usage. From the four main constructs of the UTAUT model, more emphasis is put on the three constructs; performance expectancy, effort expectancy and social influence on how they influence behavioural intentions. Facilitating conditions is the last construct which will be discussed and how it impacts the use of technology behaviour within the UTAUT model. A detailed summary of the eight constructs of the UTAUT model are discussed in the theoretical framework.

2.10 Acceptance of technology

This section has used the Technology Acceptance Model (TAM) to discuss how technology users are influenced by perceptions and attitudes to adopt and use technology. This model is very crucial because it clarifies the adoption and acceptance of technology within Mathematics education. Aspects of the TAM model and its implications on this study were discussed as follows:

Issues of ICT usage in education have left researchers wondering why others remain at entry level while others are at innovative level. The willingness and reluctance to use ICTs has prompted Fred Davis in the late 1980s to develop a powerful model called Technology Acceptance Model (TAM) (Davis, 1989). The model is purposely built and accounts for factors that encourage the adoption of technology (Davis, 1989). Its existence seeks to clarify how intention to use an ICT in Mathematics lessons is influenced by perceived usefulness, perceived ease of use and attitude towards technology. More than ten years later, researchers such as Hu, Chau, Sheng and Tam (1999) gave a different graphical interconnection of perceived useful, perceived ease of use, attitude and intentions to use within the TAM model as shown in figure 4 below.

The figure 4 below shows the relations and connectors of TAM's model.

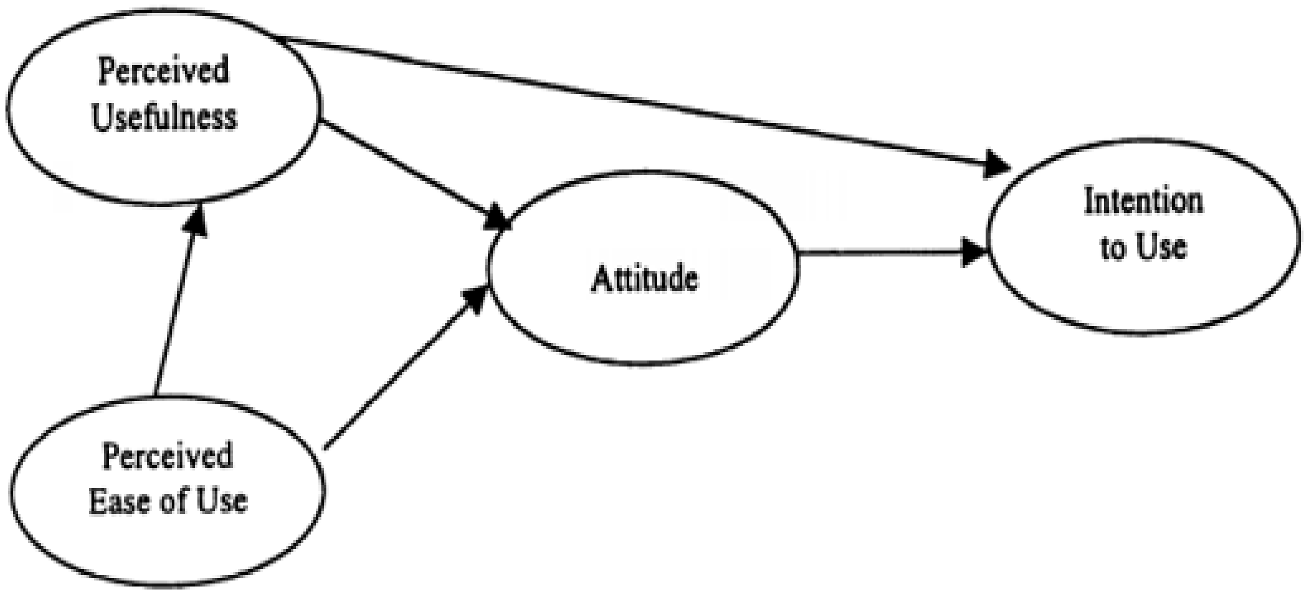

Figure 4 TAM Model

The Technology Acceptance Model was developed as a guide to predict or explain users' intentions to use technology (Al-Adwan et al., 2023). The model put emphasis on three factors; perceived usefulness, perceived ease to use and attitude, which affect users' intentions to use technology. Below is a summary of these factors and their significance to the intentions to use technology.

Perceived usefulness

Lin and Yu (2023) regard perceived usefulness as the extent to which technology users believe that technology has a potential to improve his or her work. This is known to affect user's attitude towards technology use. And attitude will likely influence behavioural intentions to use technology (Lin & Yu, 2023). Based on the TAM model, perceived usefulness and perceived ease are predictors of the user's attitude toward the technology. Records show that users of technology have shown their interest due to perceiving technology useful other than perceiving it easy to use (Al-Adwan et al., 2023). Both perceived usefulness and attitude are seen to be directly affecting the intentions to use technology.

Perceived ease to use

Perceived ease to use talks to the extent to which the user's perception on how effortless technology will be used. Perceived ease to use influences both perceived usefulness and attitude. Based on the adoption or acceptance of technology, perceived ease has been identified as one of the proponents of user's intentions to use. However, it is not directly affecting intentions to use as compared to attitude and perceived usefulness. Reasons to use technology have always been based on its benefits other than being easy to use. This is supported by Al-Adwan et al. (2023) that users will always choose software that is beneficial other than being easy to use.

Attitude

User's attitude has always been featured in the technology acceptance or usage. Attitude and perceived usefulness have been known to be high influencers of technology adoption (Lin & Yu, 2023). Although, these are not the only influencers of technology adoption, factors such as skills and knowledge have been linked to one's attitude. Hence, Lin and Yu (2023) suggest that those with poor ICT skills will likely affect their attitude towards adopting technology. Similarly, Mohoebi (2023) asserts that when teachers have the subject content, this automatically influences their attitudes and perceptions and the decisions they make in their classrooms. It is for this reason that Al-Adwan et al. (2023) insist that when capacitating teachers during technology training, we should focus more on the importance and benefits of technology because this will in turn change users' attitude. Instilling knowledge of technological benefits (perceived useful) builds a positive attitude towards technology. Teachers' intentions to use technology will eventually be elevated since they shall have developed a positive attitude which is influenced by perceived ease and usefulness.

Based on Al-Adwan et al. (2023), intentions to use technology is influenced by perceived usefulness and attitude. The level at which technology users perceive its usefulness has influence on the user's attitude towards technology. Determining the extent to which a technology can be used is dependent on the user's attitude and perceived usefulness (Lin & Yu, 2023). For Al-Adwan, et al. (2023) users of technology are likely to use technology provided it stimulates their interest and has potential in improving their learning capabilities.

Interest in using technology was found higher for those who perceive it useful than those who find it easy to use. Users of technology tend to focus on software that will benefit other than what is easy to use. Al-Adwan et al. (2023) advise technology developers to focus on programmes that benefit users to encourage technology adoption. Teachers' training should also focus on the importance of technology and its benefits towards users before it can be mediated. This will in turn change their attitude towards using technology positively. Even though there are sceptics towards the significance of attitude towards persuading users to use technology, instilling a positive attitude plays a vital role in technology adoption (Al-Adwan et al., 2023).

Acceptance of technology summary

In the late nineties, Dishaw and Strong found the TAM model to be lacking proof on the actual use of technology. A Task-Technology Fit model (TTF) was then integrated with TAM model to get a deeper understanding of "software utilization in a broader variety of circumstances" (Dishaw & Strong, 1999, p.10). Central to the TTF model is the user task needs which ought to correlate with what technology can do. For Dishaw and Strong (1999), users choose to use technology only if the functionality of technology can perform the function with ease and the technology itself becomes beneficial to them.

The integrated model (TAM and TTF) suggests that utilization of ICT is dependent on "users' perceptions of the usefulness and ease of use of the tools and general attitude toward using the tools." and matching of a specific tool functionality to the specific needs of a task" (Dishaw & Strong, 1999, p.10). The tool's functionality should match the needs of the task. Failure to match the tool with its task might result in users not showing high intentions to use the technology. The intention to use is governed by the task demands and functionality, attitude, and perceived usefulness. Furthermore, the intentions or acceptance to use does not equate to usage.

The model has been dominant in the information technology field since its inception in 1986 and continued to be cited as the most reliable model to determine users' willingness to use technology. This changed as time progressed, where limitations of the model started to surface as scholars critiqued the model (Lee, Kozar & Larsen, 2003). Even though the model suggests three significant factors which influence users' intentions to use technology, Venkatech (1999) acknowledges the importance of TAM and its contribution towards establishing user's acceptance level of technology but "deeper understanding of factors contributing to ease of use and usefulness is needed" (Lee, Kozar & Larsen, 2003, p766). Moreover, Lin and Yu (2023) suggest that there are external factors that are excluded from the TAM model such as teacher's ICT experience including development systems that may contribute significantly to the user's acceptance of technology.

The TAM model has shown potential in contributing to the adoption and acceptance of technology. However, factors such as user experience ought to be explored as they may contribute immensely to technology acceptance (Lin & Yu, 2023). The facilitation and social variables which form part of the UTAUT model may also contribute positively towards technology acceptance or usage.

2.11 Teacher's attitude in using IWB to teach Mathematics

The rate at which the Basic Department of Education put pressure on schools to produce good results, makes schools to discourage learners from choosing Science, Technology and Mathematics (STEM) subjects. Evidence can be drawn from number of learners who register for Mathematics literacy instead of pure Mathematics. With those few learners selecting Mathematics, teachers are under pressure to ensure these learners do well. As previously mentioned, in Gauteng township schools where learners do Mathematics at FET level, learner performance has been below 70%. Teachers are overwhelmed by numerous innovations deployed in schools to address poor performance especially in STEM subjects. Considering the number of years Paperless Classroom solution has been in place, the expectation was that learner performance will be high. The adoption of any technology would obviously be dependable on many factors including teacher attitude towards the technology concerned.

Teachers' background about IWB usage cannot be denied that it is influenced by their attitude. The level of significance to which attitude influences how Mathematics teachers use IWB to teach is highly debatable. As previously discussed, attitude is influenced by many factors such as perceptions, exposure, competency, level of use and confidence, frequency and experience around technology (Tombak & Ateşkan, 2019). From other researchers' prediction about teacher attitude towards technology usage, they predicted that old teachers would hold a negative attitude (Tombak & Ateşkan, 2019). Although, this might be common in developing countries like South Africa, but evidence shows that in classrooms where teachers derive joy from the use of IWB, their attitude would be positive regardless of their age difference (Al-Adwan et al., 2023). In instances where the IWB bring their best teaching abilities, their attitude would be desirable regardless of their confidence level (Tombak & Ateşkan, 2019). To boost teacher attitude towards IWB usage, Tombak and Ateşkan (2019) recommend frequent exposure to IWB and conducting teachers' training that will improve their confidence and competency level. Otherwise, teachers will continue having positive attitudes with poor usage of the IWB. Where teachers embrace IWB usage, innovation and improved teaching and learning space will be experienced (Zhao, Baharom & Razak, 2024). Although positive attitude does not guarantee high competence in IWB usage but Zhao, Baharom and Razak (2024) insist that those who embrace IWB and have positive attitudes would fully integrate it in their lesson than to use it as a projector or chalkboard.

Chiriacescu, Chiriacescu, Grecu, Miron, Panisoara and Lazar (2024) recognise the importance of positive attitude towards technology usage and emphasise on acquiring necessary skills required to use the technology since most teachers are not "natives of digital technology" (p4). As previously mentioned, attitude alone would not guarantee effective usage of technology. Chiriacescu et al. (2024) emphasise that teachers who derive pleasure from using the IWB to teach have positive attitudes. Therefore, perceived enjoyment, perceived useful, perceived ease of use and having competencies to use a technology would result in good attitude. Those who enjoy teaching Mathematics with IWB would be more engaged to explore opportunities for digital teaching and eventually, they will develop satisfaction which could result in developing positive attitudes (Chiriacescu, et al., 2024). Although the TAM and UTAUT models came with many suggestions about predictors of attitude, what came significant to Chiriacescu et al. (2024) is that those with high competence level would carry positive attitude. There is no doubt that the competency level of Mathematics teachers in using the IWB to teach has high influence in their attitude.

Attitude continues to be a challenge words technology usage; advocators of internal human innovation argue for users to have high confidence in using technology. Based on Luo, Tan, He and Wu (2023) lack of confidence in using IWB result in poor attitude, which could result in resentment of the technological tool. Hence, Luo et al. (2023) advocate for a collaborative teaching session where sharing of innovative ways of teaching Mathematics with IWB could be discussed. Otherwise, their lack of confidence would affect their trust towards what IWB can assist them which will eventually affect their attitude negatively. Such occurrences could result in teachers bringing pedagogical approaches that do not suit the technology in use.

It is highly recommended that teacher training on IWB should expose teachers to variety of functions and attributes of the IWB to influence their attitudes. Zhao, Baharom and Abd (2024) believe such trainings should not "only focus on the technical aspects but also teach the teachers on how to effectively integrate this educational tool into their teaching and learning" (p. 593). The extend to which teachers will engage one another towards sharing of skills and expanding their Mathematics knowledge on IWB usage could improve their experience. Not only would the experience be widened but they could also develop positive attitudes towards IWB usage. For Zhao, Baharom and Abd (2024), positive attitude and competent user experience relate to satisfaction and active usage of the technological tool through correct TPACK knowledge.

The TPACK knowledge provided context to the knowledge teachers need to have for effective and efficient use of IWB in Mathematics lessons. The TAM and UTAUT model provided elements which predictors value as important influencers of intentions to use technology such as perceived useful and perceived ease to use (Zhao, Baharom & Razak, 2024). As clearly put by Chiriacescu et al. (2023), these elements are in one form or another predictor of attitude. Therefore, developing positive attitudes toward using IWB to teach Mathematics content would relate to how technology is perceived. Those who carry positive perceptions around technology would certainly develop a positive attitude towards the same technology.

2.12 Conclusion

The literature review has looked at how ICT affordances, pedagogies, and practices impact on teacher preparedness towards using IWBs. The study presented three frameworks (TAM, UTAUT and TPACK) and gave account of each framework on teachers' preparedness and attitudes towards effective usage of multimodal affordances of IWB. The frameworks state that the intentions to use a device coupled with the right attitude may not result in being prepared to use technology. Technology knowledge and its pedagogical content is also crucial. It is alleged that users spend time on technological tasks that they find enjoyable and beneficial (Mayer, 2021). Therefore, it is expected that Mathematics teachers who enjoy technological task would find it easy to expose learner to activities that stretches their mental capacities. Teachers with TPACK knowledge will likely perceive technology easy to use and useful. Positive perception around technology has shown improvement on the user's attitude towards technology (Mayer, 2021). Without correct knowledge about how technology can improve teaching especially in science subject like Mathematics, one will not likely use technology (Kartal & Çınar, 2024). Preparedness of using ICTs goes along with knowledge about resources and its methodologies, selection of resources and good planning (Kartal & Çınar, 2024). Moreover, understanding of the technology and the willingness to use the technology is also important (Samsonova, 2021). Even though the TPACK model puts knowledge about technology, content, and pedagogies first, there are limitations since knowledge alone cannot determine preparedness and positive attitudes toward technology.

Technology Acceptance (TAM) model looks at the intentions to use technology based on the attitude and perceived usefulness of the technology (Al-Adwan et al., 2023). The TAM model bases its notion of technology usage on the idea that users must find the technology beneficial and easier to work with. Otherwise, users will develop a negative attitude towards technology which will in turn affect their intentions to use technology. The similarities of the two models; TAM and UTAUT have shown how perceptions govern the intentions to use the technology.

The UTAUT framework puts emphasis on the social aspects of human interactions such as social influence and facilitation conditions on users' intentions to use technology (Venkatesh, Morris, Davis & Davis, 2003). Even though the UTAUT framework does not explicitly spell out that attitude affects technology usage, it regards intentions to use technology as being affected by both performance expectancy (usefulness) and effort expectancy (ease to use) aspects. The UTAUT frameworks showed potential in determining the preparedness of teachers towards technology usage since it includes human aspects such as attitudes, perceptions and intentions to use technology. Therefore, the UTAUT framework has been used as a guide in developing a new conceptual framework for determining teacher preparedness and attitudes towards teaching Mathematics through IWB.

Chapter 3 Theoretical and conceptual frameworks

3.1 Introduction

Theoretical and conceptual frameworks blend to form an interweave that combines the research components together and point the direction of the research towards producing excellent empirical research project (Walsh & Rowe, 2023). Central to research is the application of these frameworks which could serve as a lens to investigate and explore various concepts in social studies. Conducting research without theoretical or conceptual framework can be equated to a structure without support system. Seelos, Mair and Traeger (2023) put conceptual framework at the forefront towards building a valuable knowledge in a research field. For good reflection and justification of knowledge production, frameworks could serve as instruments that provide guidance to the research project (Walsh & Rowe, 2023). Researchers are guided by these frameworks in their data presentation and analysis. The study uses the UTAUT model as a guide to develop a framework to determine the intentions to use technology. The model is considered useful to help us understand teachers' preparedness and attitudes toward using the IWB to teach Mathematics. The UTAUT model ties with the research objectives because it covers aspects such as intentions to use technology and perceptions, which fit well into teacher preparedness and attitude raised from the research question.

This chapter discusses the theoretical framework used as a lens to understand teachers' preparedness and attitudes when teaching with IWB in various schools. The theoretical foundation for this research study is the UTAUT model derived from Venkatesh et al. (2003). The conception of the UTAUT model has mostly been around, establishing technology acceptance and usage. In this research study, the UTAUT is used as a lens to ascertain teachers' attitudes that inform the usage of IWB in Mathematics classrooms. Teachers' attitude is informed by perceived usefulness and perceived ease and they both influence the user's technology acceptance. The UTAUT model itself seeks to clarify how adoption and usage of technology is influenced by human attributes (Alshehri, Rutter & Smith, 2020). Considering that the UTAUT model uses internal and external human predictors to determine the intentions to use technology, this fits well with teachers' preparedness and attitudes towards adopting IWB as a teaching and learning tool. This is in line with Ngulube (2020) who suggests that models help researchers in developing conceptual frameworks while theoretical frameworks are derived from theories. Considering the ICT cultural context and adoption of ICTs in the South African education system, the study found the UTAUT model relevant and appropriate because it addresses four most impotent construct that leads to technology usage which are performance expectancy, effort expectancy, social influence, and facilitating conditions.

Before the UTAUT model could be built, there were models that focused on various aspects in determining technology usage and adoption. Eight models came into existence one after another and researchers kept on questioning their validity. These models include Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Model of PC Utilization (MPCU), The Motivation Model (MM), Combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM), Innovation diffusion theory (IDT) and Technology Acceptance Model 2 (TAM2). These models were tested and found not convincing enough to be appropriate predictors of technology usage and adoption (Venkatesh, Morris, Davis & Davis, 2003). Eventually this led to Venkatesh et al., (2003) developing the UTAUT model that could be used to predict human behavioural intentions to use technology. Figure 5 below indicates eight different theories which influenced the UTAUT model towards understanding behavioural practices on technology usage. The UTAUT model remains the most prominent model in determining technology acceptance.

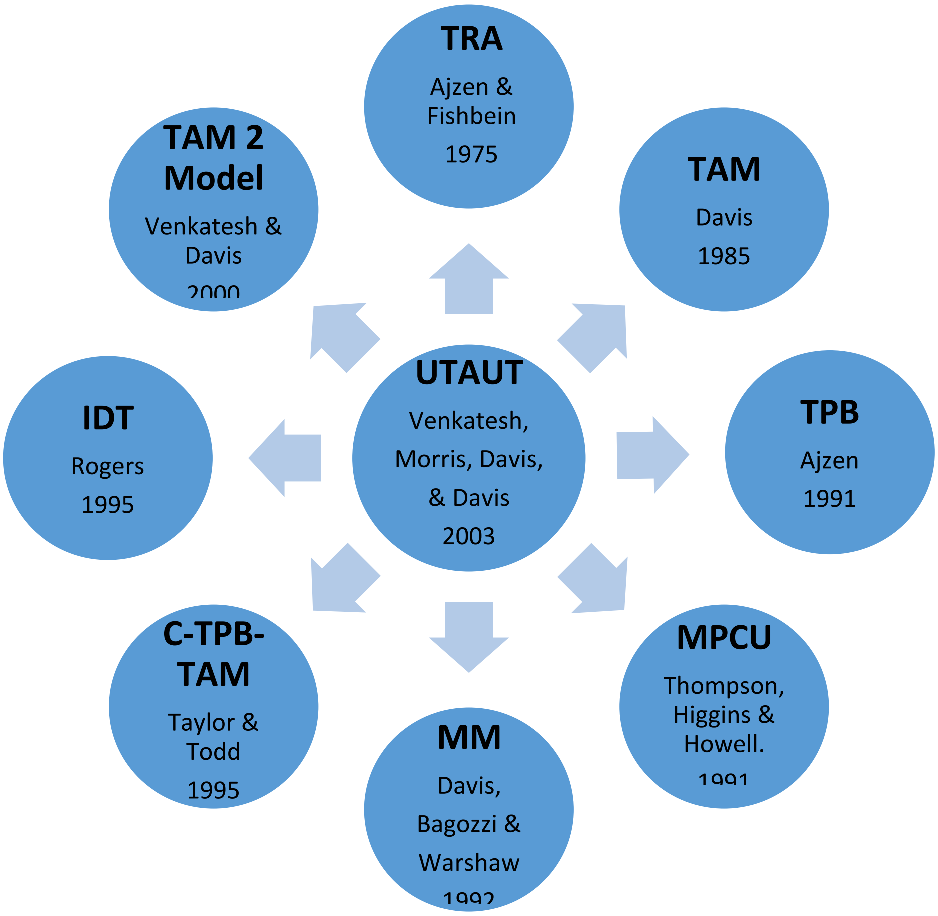

Figure 5 Theories and Models that Influenced the Inception of UTAUT model

The UTAUT model remained relevant and dominant for decades. Scholars in the commerce, governance and health faculties still use this model to gauge technology acceptance and usage (Yu, Chao, Chang, Chen, Chen & Liu, 2021). Scholars in various disciplines continue to study human behaviour towards technology through this model. Moreover, the model was successfully applied in the online stock markets to determine the adoption of technology in that economic space (Venkatesh, Thong, Chan, Hu & Brown, 2011). The model's integrated predictors of technology acceptance have influenced the adoption of various technologies in the education system. Many researchers are starting to investigate the human influences on technology especially in situations where the outcomes after testing the UTAUT model does not give the desired results (Venkatesh et al., 2011). The same goes for this study since Mathematics results in secondary schools have been very poor throughout the years and even after IWB has been introduced, results remained low. This makes the study relevant since it uses the UTAUT framework and checks its validity towards the context of the research.

3.2 Unified Theory of Acceptance and Use of Technology (UTAUT) Model

Educational technologies have become inseparable from the teaching and learning tools within the school curriculum. Research has always shown an improvement in the adoption of educational technology tools into the classroom because they recommend them as productive and innovative resources for instructional design (Venkatesh et al., 2003). However, there are questions around influencers of technology acceptance and usage. Hence, models and theories emerged to examine these influencers. Venkatesh et al. (2003) model is amongst the models that propel the notion of user intentions and behaviour towards technology usage. The model emerged after eight models illustrated in figure 1.5 were integrated and refined to produce the UTAUT model. This was because Venkatesh et al. (2003) tried to eliminate technology influencers that are not justified or considered significant.

The study explored and acknowledged the importance of the eight existing models which include the Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Model of PC Utilization (MPCU), The Motivation Model (MM), Combined Theory of Planned Behaviour/Technology Acceptance Model (C-TPB-TAM), Innovation diffusion theory (IDT) and Technology Acceptance Model 2 (TAM2). These theories are still used to determine technology acceptance in various fields. The eight models are considered important and relevant especially in another educational context. It is important to note that models such as TAM, TAM2 and C-TAM-TPB use specific constructs (performance expectancy and social influence) of the UTAUT models to determine technology user behaviour. Models such as IDT, MM, C-TAM-TPB and MPCU are found dominating in the primary construct of the UTAUT model. However, this does not make other models less important, it is imperative to note that the UTAUT model comprises comprehensive elements necessary to determine technology user behaviour. The study has discussed the first four features of the UTAUT model (performance expectancy, effort expectancy, social influence and facilitating condition) together with behavioural intentions and use behaviour. This was followed by the last four features (gender, age, experience, and voluntariness). The diagram below illustrates the construct of the UTAUT model and each construct if briefly discussed.

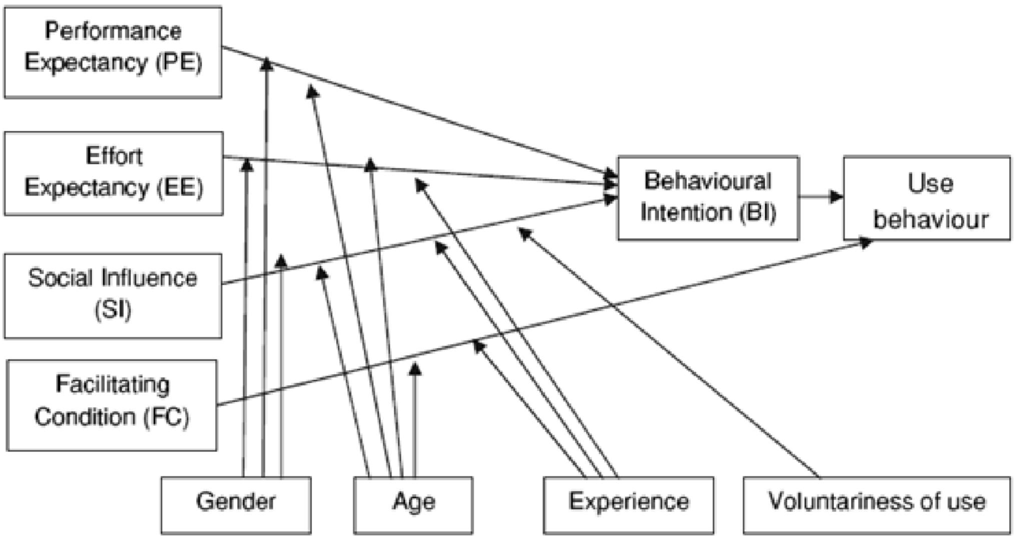

Figure 6 Constructs of UATUT Model

3.2.1 Performance Expectancy (PE)

Venkatesh et al. (2003) defines performance expectancy as the extent to which a user believes that a system will be more profitable and yield positive results. Performance expectancy is regarded as the most influencer or strongest predictor of attitudes and intentions to use technology (Rizkalla, Tannady & Bernando, 2023). Given the evolution of technology and its impact on social life, it is not a surprise that technology is expected to transform the education system and be used as a mediating tool. The same goes for IWB which are seen as technological tools to enhancing the teaching of Mathematics. The expectancy level differs tremendously due to human and social aspects. At a particular age, a user expects technology to perform certain functions especially if you have modern life experience around technologies. This is in line with Venkatesh and Morris (2000) who suggest that gender and age differences have a high impact in technology adoption. Hence, moderators of performance expectancy have been defined as the user's age, gender and experience (Rizkalla, Tannady & Bernando, 2023).

Performance expectancy has been linked to having direct effect on the behavioural intention other than usage behaviour (Rizkalla et al., 2023).

3.2.2 Effort Expectancy (EE)

Effort expectancy is defined as the degree of ease associated with the use of the system (Venkatesh et al., 2003). Technology users would love to effortlessly use technology to solve problems. Especially when technology is new, users expect new innovations to address current challenges. For Rizkalla et al. (2023), effort expectancy is relevant and important especially if a new technology is about to be introduced. Both effort expectancy and performance expectancy seem to be interrelated since they both influence behavioural intentions. Teachers expect the introduction of IWB to improve the way Mathematics content is mediated with less effort. This implies that IWB should not be difficult to use, and it should help them improve their way of teaching Mathematics. Should IWB be difficult for teachers to teach Mathematics, few teachers will develop interest in using the IWB (Andwika & Witjaksono, 2020). Teachers are likely to develop a negative attitude towards technology if more effort is needed to use the technology. For Venkatesh et al. (2003), effort expectancy on intentions to use technology is influenced significantly by attitude. Teachers' attitudes would be higher in adopting and using technology if they are satisfied with any technological tools which will ease their job.

3.2.3 Social Influence (SI)

Social influence forms part of the significant factor of intentions to use technology. However, Garidis, Ulbricht, Rossmann and Schmäh (2020) argue that its significance varies across the studies given that others have proven that attitude is the driving force of social influence. Venkatesh et al. (2003) regard social influence as the extent to which an individual's perception is governed by expectation from the society on the use of technology. Social influence forms part of the UTAUT attributes and has direct impact on the behavioural intentions. The user's intentions to use technology are entirely dependent on how others perceive that technology. Of course, the education society in the education system expects teachers to teach well especially in schools where they have invested in technology. It is not surprising that the Education department is putting pressure on Mathematics teachers because they are deemed to have IWB which should help them teach better. This is evident enough that society can serve as a reference towards social influence when using technology. Although social influence is argued to be important towards shaping user's acceptance and intentions to use technology, individualists and collectivists hold different beliefs and opinions about how individuals react to social influence (Rizkalla et al., 2023). A teacher holding an individualistic culture could care less about his or her colleagues' inputs while in a collectivist culture, a teacher will be more worried about others' perceptions (Rizkalla et al., 2023). Teachers are social beings; they are bound to interact with their superiors and colleagues. They are likely to consider using strategies and systems that are recommended by others and are perceived to be working (Rizkalla et al., 2023). Mathematics teachers are not exempted here; their knowledge and strategies of teaching with IWB would be highly influenced by their peers.

3.2.4 Facilitating condition (SI)

Venkatesh et al. (2003) define facilitating condition as "the degree to which an individual believes that organisational and technical infrastructure exists to support use of the information system" (p.534). The performance expectancy, effort expectancy and social influence do not have direct influence on the user behaviour. Their user behaviour is governed by the behavioural intentions. From the four main UTAUT proponents, the facilitating condition is confirmed to be the one which is directly linked to the user behaviour (Venkatesh et al., 2003). Mathematics teachers expect an established support structure which would be there during their struggle of using IWB to teach. Teachers are aware that their technical skills and pedagogical knowledge could be limited and therefore assistance in this regard is essential for smooth usage of IWB in Mathematics classrooms. However, availing resources and providing necessary support may not equate to usage or high intentions of using technology, teacher attitude might also be a determining aspect on technology usage (Ameri, Khajouei, Ameri & Jahani, 2020). Of course, access to resources and support could serve as the basic form of facilitating conditions where teachers become comfortable and start developing positive attitudes toward the technology. With the provision of IWB in grade 11 Mathematics classrooms, Thomas and Amaechi (2021) argue for the adoption of e-Learning systems which take cognisance of facilitating factors because they influence the behavioural intentions to use technology. Teachers could start believing in themselves if proper ICT support is provided regularly. Schools could start seeing their behaviour towards technology usage changing for better.

3.2.5 Behavioural Intention (BI)

The behavioural intention is known to be influenced by performance expectancy, effort expectancy, and social influence (Chen & Hwang, 2019). A teacher's behavioural intention to use technology is linked to his or her attitude and social influence (Andwika & Witjaksono, 2020). Teachers with high behavioural intentions to use the IWB would most likely strive to adopt this technology in his or her teaching. From the information technology background, Thomas and Amaechi (2021) suggest that behavioural intention to use technology is highly associated with the user behaviour. This suggests that those trying harder to use technology could be highly motivated by their behavioural intentions. Thus, their attitude strengthens their behavioural intentions to use IWB. Such teachers' willingness and positive strength to use technology is shown in how they mediate learning through IWB. Their attitude towards technology matches their intentions to use technology.

3.2.6 Use behaviour

With reference to the UTAUT model, user behaviour is the ultimate performance which users portray when a new technology such as IWB is adopted. The user behaviour is mainly realised when there are practices associated with UTAUT model's attributes. Teachers who portray such behaviour are deemed to be prepared and having the correct attitude to use IWB to teach Mathematics.

3.2.7 Moderating influence within UTAUT model

The discussion of the four integral parts (performance expectancy, effort expectancy, social influence and facilitating condition) together with behavioural intentions and user behaviour of the UTAUT model showed relevance of the model to this study. The discussion below includes the last four features of the UTAUT model which are known as moderating factors. For Venkatesh et al. (2003) these features (experience, voluntariness, gender, and age) are highly significant and integral to the UTAUT model.

3.2.8 Gender

People's gender on technology adoption and usage has been debated for long, some researchers such as Mondolo (2022) regards men as creatures who are task oriented and are more likely to adopt technology better than women. With men becoming comfortable with technology usage from the onset, it translates to them being more orientated to performance expectancy than women. Women are sensitive creatures; they are emotional and sensitive by nature. Although gender is more debatable in terms of its influence on technology adoption, some scholars are of the view that the social influence aspect in the UTAUT model could be more likely be linked with women than men (Mondolo, 2022). However, research has shown that gender is also dependable on age and experience Daniali, Barykin, Zendehdel, Kalinina, Kulibanova, Teor and Senjyu (2022) suggest that women's effort expectancy changes as they gain experience and grow older. Venkatesh et al. (2003) insist that "as the younger cohort of employees in the workforce mature, gender differences in how each perceives information technology may disappear" (p.469). The adoption and usage of IWB requires skills and knowledge which can be acquired regardless of gender. Thus, gender is less significant in terms of determining the readiness of an individual to use technology. This is supported by Daniali et al. (2022) that gender does not have a significant influence in the adoption of technology in commercial space. The same goes for teaching of Mathematics, one can be a Mathematics teacher regardless of gender. Moreover, the use of IWB to teach Mathematics would not necessarily depend on gender because IWB serves as a medium for content delivery. The medium cannot be gender biased, what is important is how one uses the medium to deliver content.

3.2.9 Age

Like gender, age has been noted to be playing a significant role in technology adoption (Zendehdel et al., 2022). Evidence can be drawn from titles such as 'Born Before Technology' (commonly known as BBT) and digital natives. Research shows that young workers are more likely to embrace ICT in the workplace than older generations (Venkatesh et at., 2003). However, given equal opportunity of ICT training, teachers of different ages were seen to be embracing technology equally (Blasko, Lum & Campbell 2020). Blasko et al. (2020) insist that it is misleading to suggest that women embrace technology less than men. With reference to age as a moderating factor, it is important to note that teachers of different ages utilise technology differently. There are cases where older teachers embrace technology more than younger teachers and the opposite can also be the case. The same goes for IWB integration within Mathematics content, teachers would not necessarily depend on their ages to adopt and adapt to IWB usage. The expectation is that young teachers will do well in IWB usage, although this premise is not applicable to all situations.

3.2.10 Experience

Among other moderating variables, experience is regarded as one of the significant factors of the UTAUT. Tam, Santos and Oliveira (2020) assert that users' effort expectancy decreases as they gain experience with time. Teachers gradually gain experience as they interact with technologies in their teaching. Teachers' age and gender affect their effort expectancy, but Tam et al. (2020) insist that immediately they gain experience of using technology their effort expectancy decreases. Their experience supersedes their age or gender since they are now used to the technology (Tam et al., 2020). Teachers' experience is also affecting their performance expectancy since they require technology to help them solve current and abstract problems. A teacher with high IWB usage experience expects it to have functionalities that could help him or her to mediate Mathematics content better than a teacher with less experience.

3.2.11 Voluntariness of use

Voluntariness can be summarised as an individual person's free will to use technology without any external motivation (Tambunan, 2023). Before teachers could develop voluntariness of use, technological resources should be made available and accessible. Of course, it is not automatic that availing resources and making them accessible will equate to voluntariness to use, but it could serve as an advancement towards teachers volunteering to use technologies. Voluntary use could be influenced by social influence since teachers could start using technology based on other people's assumption about technology. Even though they may not be forced to use technology, their willingness or voluntariness to use technology could be emanating from social interaction and influence from others. Teachers could develop high voluntariness to use IWB especially if they perceive technology to be useful and beneficial. To improve teachers' poor performance in Mathematics, researchers have recommended IWB as one of the technological tools which could mediate content better (Samsonova, 2021). However, the inner wiliness and volunteerism must drive teachers towards using the IWB to teach.

3.3 Conclusion

Various sectors ranging from health, small and big enterprise, financial institutions, and education have dominated their research in establishing the acceptance of technology through the UTAUT model. Since the inception of this model, most Western and Asian countries but not excluding few African countries, have established technology acceptance in many accounts through this model. With reference to the adoption of modern technologies, researchers have used features of the UTAUT model interchangeably based on their preferences and context (Long, Cummins & Waugh, 2019). While the model continues to be dominant in the education sector, scholars have raised limitations of the UTAUT model due to its features failing to account for full adoption of technology in various context (Zaineldeen, Hongbo, Koffi & Hassan, 2020). Nonetheless, Venkatesh et al. (2003) acknowledges the limitations since they argue that the model does not account for 100% technology acceptance. Depending on the context and nature of technology, critics of the UTAUT model insist that features of this model could be applied selectively (Zaineldeen et al., 2020).

The study acknowledges the contribution of the model and its underlying features towards determining user's technology acceptance. With reference to the literature and the UTAUT model, the study seeks to adopt new aspects which according to the research's context could form part of the integral part of the new conceptual model. Moreover, based on the context of the study, the new conceptual model has used relevant features of the UTAUT model to determine teachers' preparedness and attitudes in using IWB to teach during Mathematics lessons.

Human influence on technology usage such as Performance and effort expectancy of the UTAUT model are known to affect teachers' willingness and attitude toward technology usage. From the eight features of the UTAUT model, the study has outlined their influence on technology adoption and usage. What is deemed more important to this study is the unpacking of experience because is not seen as exposure or access to a resource. The section below discusses aspects of experience being TPACK knowledge and experience of teaching with ICT resource affect teachers' willingness and attitudes and how that links to teacher preparedness.

3.3 A conceptual model for Interactive Whiteboards usage in Mathematics lesson

The study acknowledges the contributions of the UTAUT model and is considered essential for establishing the user's intentions to use technology. Although Venkatesh et al. (2003) model propels the notion of user intentions and behaviour towards technology usage, other influencers of technology acceptance and usage have been explored. Scrutinising influencers of technology usage within the UTAUT model has helped the study to answer the research question which seeks to understand how teachers' preparedness and attitudes affect the effectiveness of using the multimodal affordances of the Interactive Whiteboards into teaching of Mathematics content. Emphasis is put on new aspects which contribute significantly towards influencing teachers to use technology (IWB) to teach Mathematics. These are TPACK knowledge and the experience of using ICT to teach which collectively contribute to the experience depicted in the UTAUT model. The model below shows how experience is influenced by the two aspects (TPACK knowledge and the experience of teaching with ICT). The study argues that user experience is not simply about the frequency of using an ICT device, but it should include the correct pedagogical technological content knowledge and experience of teaching with the ICT device. The experience of using a device cannot be equated to the experience of teaching with the device. Teachers must be comfortable users of IWB first, with time, more experience is gained through using the IWB to teach Mathematics. Teachers with teaching experience of using IWB to teach have less effort expectancy because their technological skills lessen perceptions of seeing IWB as a burden or a tool that requires more effort and time (Tam, Santos & Oliveira, 2020). Figure 7 below depicts a conceptual model for teacher preparedness and usage of IWB drawn from UTAUT model followed by a brief discussion about the model's components.

3.3.1 Conceptual model

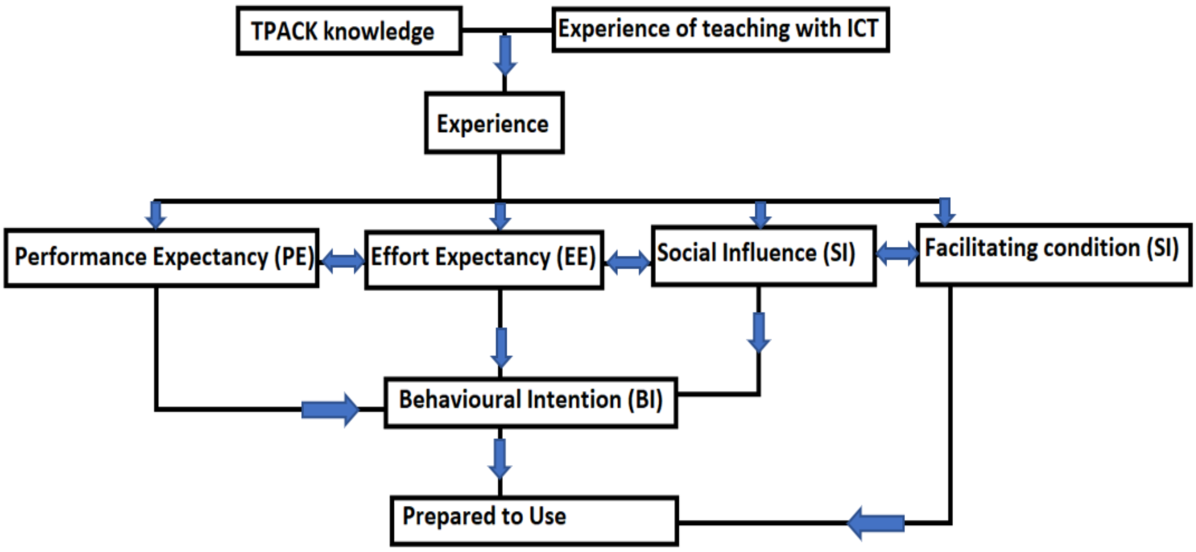

Figure 7 Teacher Preparedness and Usage of IWB Model

3.3.2 Experience

From the context of the study, the TPACK knowledge and experience of teaching with ICT constitute user experience. The study does not count a mere usage or number of years of using the technology as experience, but its emphasis is on the experience gained from teaching with technology and correct knowledge which accompanies the technology. A brief discussion on how TPACK knowledge and experience of teaching with ICT form a collective user experience is discussed as follows:

3.3.3 TPACK knowledge

TPACK model aims at integrating knowledge components of technology, content, and pedagogy (Raygan & Moradkhani, 2020). Although teachers are specialists in content and pedagogical knowledge, they are encouraged to possess the TPACK knowledge because it incorporates all sets of knowledge relevant for the 21st century. Teachers with TPACK knowledge, evaluates technologies and pedagogies relevant for content knowledge. Integrating these sets of knowledge creates a synergy between pedagogies to be applied to teach content through appropriate resources. Hence, Raygan and Moradkhani (2020) put TPACK model as a set of knowledge which teachers must possess because it encompasses relevant methodologies of teaching subject matter through technology for effective teaching and high interaction.

3.3.4 Experience of teaching with ICT

The adoption of technology is influenced by many factors. Throughout the adoption process of these technologies, one gradually gains experience of using technology. The UTAUT model uses experience as the predictor of technology acceptance. Based on this research context, experience of using technology is phrased as experience of teaching with ICT. From the perspective of Venkatesh et al. (2003), those with experience have less effort expectancy because over time, users become less concerned with efforts of using a technology. Those with less experience would become concerned with both effort expectancy and ease of use. Hence Venkatesh et al. (2003) suggest that effort expectancy would be a concern only to those with less hands-on experience. However, as they gain experience of using technology, their effort expectancy and ease of use expectancy are overshadowed by their competencies. User experience gained from hands-on and formal training builds confidence and helps develop positive perception in using technology (Venkatesh, 1999).

3.3.5 Performance expectancy

This is an expectation which is associated with the usefulness of the technology in yielding results that will prove work performance. Performance expectancy in this case is seen as the level at which Mathematics teachers believe that using IWB will improve teaching and learning in the classroom. They are driven by motivation and new thoughts about IWBs that through these technologies, more positive results will be realized at the end of the lesson. Although teachers in this study acknowledged the importance of IWB, their performance expectancy about IWB was that technology will lessen their teaching time and improve how content is mediated.

3.3.6 Effort Expectancy

In this case, teachers perceive usage of technology as an easy process, no difficulties are anticipated in a technology enhanced classroom. The IWB as a technological tool is perceived as an effortless tool that has potential to change teaching and learning culture in a Mathematics classroom. Teachers believe that IWB will not hamper teaching progress, since its operation is free from challenges. In this research, teachers' expectancy about IWB has emerged commonly as a technological tool that can improve teaching and learning.

3.3.7 Social influence

This expectation is with reference to people's perception in relation to how an individual uses technology to mediate learning in the classroom. Teachers justify the usage of technology based on the pressure emanating from the society. How people think of them in relation to IWB usage gives indication of how the technology is being used. In this case, a teacher does not want to tarnish his/her reputation hence the sensitivity towards peoples' perception on IWB usage. This puts pressure on the teacher concerned to keep up and adopt IWB as it gives him/her a sense of belonging. Without a social influence, positive competition and self-motivation could be ignored.

3.3.8 Facilitating conditions

The expectation here is that teachers expect technical and organisation support to ensure that technology is used with ease. During technological usage, teachers believe that there is a need to acquire skills and knowledge through support structure. Teachers in this context expect knowledgeable personnel to give them support on the usage of IWBs. Fauzi et al., 2021) support interaction amongst users other than relying on the tool's technical attributes for solutions. Moreover, they suggest that through organisational development, users should leverage the affordance of the tool to improve communication and collaboration amongst peers (Fauzi et al., 2021). From this research context, teachers relied on technical support from technicians who ensured that technical challenges were addressed to facilitate smooth delivery of Mathematics content.

3.3.9 Behavioural intention

Behavioural intention forms part of the integral predictors of technology adoption. The adoption of technology in turn determines the preparedness of users of technologies. Users with high behavioural intentions and facilitating conditions are deemed prepared to use technology for teaching and learning. Those with high expectations to use IWB to teach Mathematics but having less effort expectancy, have a positive attitude towards adopting IWB. The same goes for performance expectancy and social influence; users who expect technology to improve their performance would be motivated to use the technology. The higher the user's intentions to use technology, the more motivated the user becomes, and the adoption of technology becomes a reality (Thomas & Amaechi, 2021).

3.4 Conclusion

This chapter has used the theoretical framework as a lens to understand teachers' preparedness and attitudes when teaching with IWB in various schools. The UTAUT model derived from Venkatesh et al. (2003) guided the study in establishing technology acceptance and usage. The explanation and relevance of the UTAUT model was clarified based on the context of the study. A brief discussion of the eight constructs of the UTAUT model built from technology influencers that Venkatesh et al. (2003) considered significant was provided. The study modified the eight justified influencers of behavioural intentions and user behaviour from the UTAUT model to formulate a conceptual framework consisting of significant contributors of experience for instance TPACK knowledge and experience of teaching with ICT. The findings of the study influenced the conception of the modified conceptual model named Teacher Preparedness and Usage of IWB model (figure 3.3). The research findings in chapter 5 demonstrates the significance of the modified UTAUT model and Teacher Preparedness and Usage of IWB model towards establishing teacher's intentions to use technology. The social constructivism theory which is briefly discussed in the next chapter aligns perfectly with the UTAUT model because it argues for social construction of knowledge. The artifacts UTAUT model also recognises internal and external human factors as key contributors to technology adoption. And this is in accordance with Vygotsky's notion of environment having influence on how a child acquire knowledge and development (Vygotsky, 1978). Hence for this study, constructivism is regarded as pedagogical philosophy underpinning why multimodality matters for knowledge creation and mediation of content in IWB enhanced classrooms. The next chapter gives an overview of how the study used the research methodology, methods, design and the philosophical foundation to synthesise and arrive at the findings.

Chapter 4 Research methodology

4.1 Introduction

The study seeks to develop an in-depth understanding of the multimodal affordances of Interactive Whiteboards and to explore teachers' preparedness and attitudes towards the integration of IWBs as pedagogical tools in teaching of grade 11 Mathematics content. Firstly, this chapter gives a description of the research paradigm guiding the study. The research design, areas of study, data sampling, population size, data generation and data analysis are briefly discussed. The last section of this chapter covers issues of trustworthiness and ethical issues.

4.2 Research paradigm

This section gives an overview of the research paradigm and its components for this study. Four paradigms which are well grounded within the educational research are explored to determine their relevance to the research study. The pragmatism and its practical application are the most suitable paradigm to be used as a lens to describe how the study is moulded.

The theory around paradigms emanated from researchers seeking to understand how people view the world and their assumptions or perceptions around them. Allemang, Sitter and Dimitropoulos (2022) regard a paradigm as a system of practices that influences how researchers choose questions and methods as well as their procedure of studying for them. In a research context, Nigussie and Bekele (2021) are of the view that, a research paradigm are common sets of beliefs and practices researchers hold on to in addressing problems. These beliefs and practices are known to govern one's perception about the world. Based on Ugwu, Ekere and Onoh (2021), a paradigm is made up of four components which are briefly discussed as follows:

1. Ontology – beliefs about reality (how things really are and how things really work)
2. Epistemology – the relationship between the researcher and what can be known (how knowledge can be created, acquired, and communicated. In other words, what it means to know).
3. Methodology – how to carry out the research relative to the question and context (strategy or plan of action which lies behind the choice and use of a particular method).
4. Methods - techniques and procedures that are used to collect and analyse data.

The table 2 below is developed from Guba and Lincoln (1994); Creswell and Poth (2016); Khatri (2020) and Ugwu, Ekere and Onoh (2021) and it summarises four paradigms according to their components.

Table 2 Philosophical Paradigms

Paradigms	Ontology	Epistemology	Methodology	Methods
1. Positivist: (Single stable truth and reality does not depend on an individual)	Objective and external comprehended reality.	Viewpoints are objective and are based on a dualism approach. Findings are true.	Experimental and manipulative. Questions are posed proportionally and empirically tested.	Support quantitative research approach.
2. Post-Positivist (Solutions are driven by circumstances)	Imperfect reality which is understood to have uncertainties.	Viewpoints are objective and are based on a modified dualism approach. Findings are probably true.	Modified experimental and manipulative. Modified triangulation for falsifying hypotheses.	Support a modified quantitative research approach which may include a qualitative research approach.
3. Critical Theory and Critical Race Theory (CRT) (Impact of racial segregation on people's way of living)	Historical realism, reality shaped by social, political, cultural, economic, ethnic, and gender values.	Support subjectivism which is based on real world phenomena and linked with societal ideology.	Interrogating of values and assumptions, exposing hegemony and injustice, challenging conventional social structures.	Follows a qualitative research approach aiming to produce highly contextualized data.
4. Pragmatist (World is dynamic with diverse reality)	Various or diverse views about social reality.	Viewpoints are flexible and depend on the research stage, Viewpoints can be both objective and subjective.	Focus on the reality and the laws of nature other than experimenting.	Both quantitative and qualitative research approaches are supported.

4.2.1 Positivist Paradigm

The positivist paradigm bases its existence on a single stable truth and reality which does not rely on an individual's perception or interpretation (Khatri, 2020). Positivists believe that the society belongs to the world that is governed by unchanging laws and principles. Within the positivist paradigm, scientific methods associated with quantitative research are used to generate and analyse data to establish knowledge about reality (Ugwu, Ekere and Onoh, 2021). The denial of the viewer's perception about the world and scientific methods which are only based on quantitative research makes the paradigm to be less appropriate to this study. The positivist's way of understanding the world through experiments and observations also make it irrelevant for this research study. The study uses questionnaires and interviews to gather data.

4.2.2 Post-Positivist paradigm

The post-positivist paradigm's existence is from the positivist principles. However, it does not concern itself with only testing the truth and reality, but it assumes that truth and reality happen as we interact with one another. The paradigm does not separate a researcher from the participants because it suggests that learning happens as one seeks to understand the truth and reality (Maksimovic & Evtimov, 2023). It regards the research method of positivist paradigm as a representational thought other than social construction thoughts produced during the interaction (Maksimovic & Evtimov, 2023). The paradigm understands that circumstances affect the way we view things, therefore we cannot have one solution to a problem, solutions change with time (Maksimovic & Evtimov, 2023). It uses mainly the qualitative research approach but does not negate the elements of the quantitative approach. Due to the paradigm's methodological stance of modified experimental and manipulative, the researcher will not use this paradigm. Even though the paradigm supports a social narrative response from participants, it does not give a balanced outcome from both qualitative and quantitative approaches (Maksimovic & Evtimov, 2023).

4.2.3 Critical Theory and Critical Race Theory (CRT) paradigm

The two theories base their existence on the understanding of social structures and their influence on human interaction. The critical theory focuses on dismantling factors of social life that obstruct human freedom (Asghar, 2013). The theory exposes all old styles of thinking and suggests alternative human relations that promote justice, equitable access of resources to all and non-discrimination (Asghar, 2013). Human beings are empowered to challenge their contextual uncertainties emanating from racial or class domain (Delgado & Stefancic, 2023). CTR goes beyond human social interaction and tries to understand how racial segregation affects people's way of living. The theory puts discrimination at the forefront and suggests that favours and prejudices exist because of race differences (Delgado & Stefancic, 2023). The Critical Theory and Critical Race Theory support a qualitative approach since its data is centred around descriptions and interviews to determine discriminatory occurrence (Delgado & Stefancic, 2023). Use of a single research approach (qualitative) makes the paradigm not to be compatible with the study. The paradigm does not match the study because it bases its existence on investigating discriminatory occurrence or racial challenges whereas the study focuses on the preparedness and attitudes affecting the integration of IWBs.

4.2.4 Pragmatist paradigm

A pragmatist paradigm which perceives the world different from the positivist seems to give a similar account to the social constructivist theory. From Creswell's (2021) perspective, pragmatists perceive the world as dynamic entity influenced by its dwellers. Pragmatism philosophy focuses on logical inquiry throughout the human experience (Creswell, 2021). The inquiry seeks to discover the problematic situations that emerge or are realised throughout human existence. Moreover, these problematic situations emanate from worries which are concerned about an individual's existing set of belief systems (Creswell, 2021). This philosophy is relevant to this study since it bases its inquiry on human experience, and the study also explored teachers' preparedness and attitudes towards effective integration of IWBs into teaching of grade 11 Mathematics content. Human experience is gathered through various forms; teacher preparedness and attitudes are attributes of experience which shape the adoption and usage of technology. Understanding teacher preparedness and attitude on technologies relates to the enquiry teachers experience and background. Therefore, pragmatist approach aligns with the research question because they both seek to understand how human relates to the technologies around them.

Pragmatism inquiry involves scientific procedures undertaken in real and practical situations (Creswell, 2021). Furthermore, judgements are based on practical experiences. In this research, judgement is based on how teachers practically apply their ICT skills to teach Mathematics in the classroom. Teacher interaction with learners, content and technology have also shown pedagogical styles used during teaching and learning. Inquiry was made based on the actions and practices emanating from these interactions.

Pragmatists are of the view that knowledge is generated and constructed through social interaction, and this is in line with Jean Piaget and Lev Vygotsky's theory of social constructivism (Feilzer, 2023). Reality is experienced by interacting with the world (living and non-living) and that is how people get to gain knowledge. It is through these interactions that inquiries are generated to improve human life. Pragmatism regards problem solving as a continual phenomenon, where solutions are not permanent but are based on the notion of constant improvement of what seems to be the answer to the problem (Feilzer, 2023). All these improvements emanate from a practical and scientific inquiry which seeks to obtain the appropriate and significant truth.

From a pragmatist point of view, doubts are cleared through critical reasoning and later put to test through action (Creswell, 2021). The research has used questionnaires and interviews to establish teachers' perceptions about IWBs usage. Interviews helped to verify the nature of ICT integration taking place in Mathematics classrooms. My interest lies in the nature-of-being theory and has prompted me to investigate the way in which teachers' preparedness and attitudes affect the integration of IWB in Mathematics content.

This research study used the pragmatist approach because of its practical inquiry method of investigating occurrences aided by human experiences. The pragmatist approach of valuing participants' experience and their interaction with the world in addressing social problems makes it more relevant to this study. For pragmatists, what is valued as educational content or solutions is negotiated and shaped by human interaction with the world (Andrew, Wallace & Sambell, 2021). Knowledge evolves, therefore solutions to problems cannot stay the same. Similarly, what counts as knowledge today could be interrogated and changed due to future circumstances (Andrew, Wallace & Sambell, 2021). In this case, the pragmatist approach of assessing and validating what is practical and relevant to the situation at hand aligns itself with the research's question which seeks to examine teachers' preparedness and attitudes towards using the multimodal affordances of the Interactive Whiteboards in Mathematics classrooms.

4.3 Philosophical Foundation Adopted in the study.

4.3.1 Introduction

The study is framed within the social constructivist approach which is predominant within Mathematics education. The study gave a brief background about constructivist approach before exploring the social constructivist approach.

4.3.2 Constructivism theory

Constructivism theory is centred around three predominant theorists called Jean Piaget, Lev Vygotsky and Jerome Bruner. Piaget is of the view that as a child grows, learning takes place. A child creates his or her own reality through experience. For learning to occur, Saracho (2023) suggests that a child's cognition is constructed and modified by his or her society and environment through social interaction. Piaget recognises cognitive development as a process which unfolds in sequential stages and follows at a specific pattern that differs from one stage to the other (Oesterdiekhoff, 2021). However, Vygotsky sees child development as independent from learning (Vygotsky, 1978). Similarly, Bruner also sees learning as independent from development and that new knowledge is acquired using current knowledge (Bruner, 1974). Essentially, a child gets to access, know, and understand new knowledge through social interaction amongst people in a society. The society a child lives in and the culture he/she is embedded brings together a vast great deal of knowledge. Regardless of their different perspectives about what supersedes the other in terms of learning and development, the three constructivists agree that knowledge and understanding of an individual learner is constructed over time as they act on their environments and engages in social activities. Constructivists argue for learner centred instruction other than teacher centred. Teachers are encouraged to create a learning environment that promotes active learning. Learners in this environment are known to actively construct knowledge through interaction with peers, learning materials and teachers (interactivity theory).

Social constructivism view knowledge as not passively acquired but is constructed through interaction with the world's artifacts (Saleem, Kausar & Deeba, 2021). Fundamental to Vygotsky's theory of social constructivism is the idea of the Zone of Proximal Development (ZPD). For Vygotsky, a collaborative achievement of a particular task empowers individuals the ability to perform the same task independently form others in the future (Vygotsky, 1978). He suggests that it is in the zone of proximal development that learning is internalised, processed and actively interact with the environment and the society to achieve independent development (Vygotsky, 1978). New knowledge is constructed through internalising concepts, establishing links with the environment (objects and tools) and getting assistance on abstract concepts.

A social constructivism theory bases its existence on how knowledge is acquired throughout a learner's development. Vygotsky is of the view that cultural artefacts contribute to the child's development and knowledge acquisition (Vygotsky, 1978). Development and knowledge acquisition cannot be separated since a child is embedded within the society. The research study associates a teacher with a learner since teachers are known to be long-life learners, they ought to acquire knowledge and interact with ICT tools to mediate teaching and learning. Where teachers seem to be lagging in knowledge, the social constructivist theory of ZPD can be applied as a development strategy to move them to the desired level. During the intervention strategies, teachers are assumed to be acquiring knowledge and developing skills which will be used independently from the instructor.

A teacher in a constructivist platform can access and work within what Vygotsky defines as the ZPD, where learners are assisted to acquire potential development (Vygotsky, 1978). In this case, teachers assume a new role of being instructors and advocates of ZPD principle. Teachers' ought to help learners to exceed the boundaries of what they can achieve on their own and provide new areas for exploration about the subject matter. Of course, ICT resources are known to assist teachers to mediate content with ease and promote active, meaningful and practical teaching experience. However, this can only be a reality if teachers use adequate pedagogical approaches such as experimenting, modelling, coaching, classroom discussion, debates and expose them to meaningful activities that appeal to their context (Ghani, Rahim, Yusoff & Hadie, 2021).

IWBs are part of technological tools which afford lots of opportunities to teacher. They were not made to replace teachers but to enable them to innovatively deliver content in a more diverse and structured manner. Cadamuro, Bisagno, Di Bernardo, Vezzali and Versari (2020) regard ICTs as tools that enable a teacher an interesting teaching than usual chalkboards that do not provide interactivity. They insist that the audio, visual and kinaesthetic nature of the IWB ensures that learning becomes diverse, and learners become problem solvers through discovery learning (Cadamuro et al., 2020). It is through these ICT affordances that teachers can intervene and use them to facilitate learning and assist learners to reach their high learning potential. However, a teacher's interventions alone cannot influence a child's knowledge constructions. Learner experience is also crucial for knowledge creation and social development (Saracho, 2023).

Social interaction with the world and peers is critical for teachers' development. Teachers must be exposed to new technologies and methodologies to teach in the 21st century. This is in line with Zhang, Khan, Dagar, Saeed and Zafar's argument that in human development, one's exposure and interaction with the environment is a valuable educational growth (2022). For one to grow socially and professionally, formal, and informal interaction with society and the surrounding is key. Zhang et al. (2022) see ICT tools as suitable to mediate learning and that, they must not be isolated from an individual's social interactions but rather be used to strengthen social interactions. Computer based activities are capable of mediating learning only if the activities are authentic (Chiu, Moorhouse, Chai & Ismailov, 2024). However, these activities must be designed with consideration of the cultural context of the learner. They should involve communication, collaboration and interactions with other members of the society (Chiu et al., 2024). Users of technology are known to excel in their studies, provided they become highly engaged and interrogate the feedback they receive from the teachers (Masana, 2024).

The social constructivist approach is in line with the researcher's point of view that learning is a social phenomenon that happens when the mind is active and fully engaged. Drawing from Vygotsky's theory, the research supports the idea of social interaction that occurs during IWB usage. According to Maryam, Sören and Gunilla (2020), the multi-modality of the IWB ensures that users have access to interactive online and offline platforms which assist to mediate content that caters for various learning methods. The interaction enables teachers and learners to use the affordances of IWB to make teaching and learning more meaningful.

4.4 Research design

A mixed method research design was used for this case study. Firstly, it is crucial to understand the importance and relevance of a case study for this research. Researchers hold different views about what case study means. Hancock, Algozzine and Lim (2021) recognise case study as a specific group representation confined by certain parameters and time within a specific context. In contrast, Stake (1995) describes a case study as a complex phenomenon that requires an interpreter to examine the working case objectively, refine and substantiate the meaning. It is recommended that a case study is considered having various data sources (Hancock, Algozzine & Lim, 2021). This research has done so by building on narratives from participants to build an academic form of reporting. It was achieved by examining participants in depth and exercising fairness within the process.

A mixed method approach became more appropriate in producing quality data that is collected both qualitatively and quantitatively. The outcomes of the research are dependent on the experience of participants (teachers) in responding to the questionnaires related to their preparedness and attitudes towards integrating IWB to teach Mathematics content. The collected data has informed the extent to which teachers pedagogically integrate Interactive White Boards into Mathematics content. A parallel mixed design strategy was used to achieve present coherent findings and to obtain what Dawadi, Shrestha and Giri (2021) recommend as a process of validating two sets of data (qualitative and quantitative) to arrive at triangulated results. Both qualitative and quantitative data collection and analysis techniques were used separately without any interference from the two strands. Data was first presented qualitatively and followed by a quantitative presentation. The two data presentations were guided by four parallel mixed design strategy stages, namely, conceptual, experimental methodological, experimental analytical and inferential stages (Dawadi, Shrestha & Giri, 2021). Through these stages, an accurate and reliable meta-inference or conclusion was generated by integrating both quantitative and qualitative inferential analysis (Dawadi, Shrestha & Giri, 2021).

The mixed method enabled the researcher to have deeper knowledge about participants since data was generated through interviews and questionnaires. The mixed method approach helped to study the events thoroughly because it encourages the study of events from people’s responses through questionnaires and interviews. It also explained the nature of practices taking place when IWBs are used in grade 11 Mathematics classrooms.

4.5 Areas of study

The study focused on five Gauteng based public secondary schools located in Tembisa township under Ekurhuleni North District. These schools were chosen on the basis that the current premier of Gauteng who was the Provincial Minister of Education by then rolled out Paperless Classroom solution in most townships' secondary schools. Millions of rands were spent on the Paperless Classroom solution and schools were equipped with ICT resources ranging from IWB, tablets, laptops, connectivity and servers. The rationale for this roll-out in public township schools was to address the digital divide from the legacy of the apartheid. The five chosen schools are classified as former needy schools because they are in the so-called disadvantage areas. The schools have IWBs in grade 11 and 12 classrooms. Individual teachers in the schools have laptops loaded with personalised content as per subjects they teach. The study could help teachers to evaluate their readiness and preparedness to teach Mathematics content through IWBs and explore their pedagogic practices during content delivery.

4.6 Population

The study's population consist of ten professional township secondary school teachers. Each school is represented by two teacher and their schools are classified under quintile 1 to 3 schools. These are schools situated in low socio-economic areas and they are mainly located in South African townships and rural areas. Teachers' teaching experience in these schools varies and so is their experience of using IWB to teach Mathematics and other subjects. Table 1.3 (Participants' career history) provides summary of their career history and distinction of their experience around IWB as a teaching tool. Although few participants are Department Heads (HoDs), and that some of their duties include supervision of other teachers, their main duty is to teach Mathematics. Similarly, those occupying junior positions (ordinary teachers) are also expected to teach. All participants are permanently employed and deemed to be qualified to teach Mathematics since Mathematics is their major subject they are qualified to teach.

4.6.1 Participants' background

As previously mentioned in the section discussing "areas of the study", the five no-fee paying public secondary schools that participated in this research study are situated in Tembisa Township. All schools have Grade 8-12 classrooms and their roll ranges from 1000 to 1500 learners. Teachers in the five schools are using IWBs in Grade 11 and 12 classrooms to enhance teaching and learning. The five schools have started benefiting from the Paperless Classroom solution since 2016 and are classified as ICT phase two schools. However, there are teachers who have used the IWBs before the Paperless Classroom solution could be implemented. Table 3 below provides participants' career history in their schools followed by a user category indicator table for ICT skills classification.

4.6.2 Participants

Giyani - represents participant 1 from school A

Lephalale - represents participant 2 from school B

Capricorn - represents participant 3 from school C

Makhado - represents participant 4 from school D

Modimolle - represents participant 5 from school E

Mopani - represents participant 6 from school A

Musina - represents participant 7 from school B

Vhembe - represents participant 8 from school C

Waterberg - represents participant 9 from school D

Sekhukhune - represents participant 10 from school E

Table 3 Participants' career history

Participants	Gender	Age	Designation	Teaching experience	Number of years teaching Mathematics	Number of years teaching with IWB	Number of years teaching Mathematics in grade 11	Number of years teaching Mathematics with IWB in grade 11	Technical and Pedagogical skills (basic, average, or advance user)	Technical and Pedagogical skills acquired through (formal or non-formal training; Personal experience "trial and error"; User Manual; Referral / social interaction)
Giyani	Female	40	HOD	10 years+	10 years+	Between 4 -10 years	Between 5 - 10 years	Between 6-10 years	Advance	Formal & trial and error
Lephalale	Male	43	HOD	10 years+	10 years+	10 years+	10 years+	Between 6-10 years	Average	Formal
Capricorn	Male	29	Teacher	Between 1 - 3 years	Between 1 - 3 years	Between 1- 3 years	Between 1 - 3 years	Between 1- 3 years	Average	Trial and error
Makhado	Female	52	Teacher	10 years+	Between 6 - 10 years	Between 7 – 10 years	Between 6 - 10 years	Between 2 - 5 years	Average	Formal

Modimolle	Male	30	Teacher	Between 3 - 5 years	Between 4 - 5 years	Between 1 - 5 years	Between 1- 3 years	Between 1- 3 years	Average	Trial and error
Mopani	Male	29	HOD	Between 8 – 10 years	Between 2 - 5 years	Between 1 - 3 years	Between 3 - 5 years	Between 1- 3 years	Advance	Trial and error
Musina	Female	42	Teacher	10 years+	10 years+	Between 3 – 5 years	Between 3 – 5 years	Between 3 - 5 years	Basic	Formal
Vhembe	Male	32	Teacher	Between 5 – 5 years	Between 4 - 5 years	Between 1- 3 years	Between 3 - 5 years	Between 1- 3 years	Basic	Formal
Waterberg	Male	31	Teacher	Between 6 - 10 years	Between 3 – 5 years	Between 1- 3 years	Between 3 - 5 years	Between 1- 3 years	Advance	Trial and error
Sekhukhune	Female	36	Teacher	10 years+	10 years+	Between 3 - 5 years	10 years+	Between 1- 3 years	Average	Training & Trial and error

For compliance with ethical principles, all participants have been given pseudonyms, and their description is arranged according to pseudonym, school code (S letter) and telephonic interview (TI) or questionnaire (Q). Below are pseudonyms of the ten participants and their schools. An abbreviation showing full description of the participants will follow.

Abbreviations

Participant: Giyani (Pseudonym)

School code: SA (From School A), SB (From School B), SC (From School C), etc

Data type: TI (Telephonic Interview) or Q(Questionnaire)

An example of participant's full description could either be:

1. GiyaniSATI or GiyaniSAQ

2. LephalaleSBTI or LephalaleSBQ

Participant's citations will be followed by their full description. An example of citation with full description is provided below:

When teachers were asked how IWB helped them to teach effectively, one of them responded as follows:

It captures learners' attention and makes them participate during the lesson (GiyaniSAQ).

User category and indicators

The ICT user category classification gives guidance to a teacher's technical knowledge and skills around ICTs. Contents of the key indicators may overlap according to skills level and depth. Table 4 helps in gauging teachers' skills level and knowledge needed to be applied to teach through ICTs. Through this table, a teacher could be classified as a basic, intermediate or advanced IWB user (as indicated in Table 1.4 under Technical and Pedagogical skills column) based on the key indicators depicted in the table.

Table 4 Teachers' Skills Level and Knowledge

Category	Key indicators
Basic User	1. Use Interactive Whiteboard software to teach (free handwriting and projecting media). 2. Manipulate shapes (moving, resizing, and filling in colour) on the board to suit your teaching style. 3. Use the Gallery (search, insert clip art and interactive games in the gallery) to enhance your teaching. 4. Ability to navigate through the board. 5. Limited application of digital pedagogies in IWB classroom. 6. Locate and minimally use resources and content to enhance learning (e-Books, Presentations, Multimedia, Podcast, etc.)
Intermediate User	1. Group and move objects according to lesson specific outcomes. 2. Use multimedia and e-Books content to teach. 3. Use Lesson Activity Toolkit (LAT) to develop an interactive lesson. 4. Use My Content in the Gallery to add subject content such as pictures and videos.

	5. Use the screen capture to take a snapshot from another program that is relevant to your topic. 6. Average use of digital pedagogies in IWB classrooms. 7. Average use of resources and content to enhance learning (e-Books, Presentations, Multimedia, Podcast, etc.)
Advanced User	1. Use the lesson recorder/smart recorder to capture the events during the lesson. 2. Link web pages and pages in the Interactive White Board (Notebook) to expand content exposure. 3. Create animations using object properties to improve information presentation. 4. Create your own themes and pull tabs. 5. Use Smart Response (Interactive Programme) to create, export and analyse results. 6. Creative use of digital pedagogies in IWB classrooms. 7. Innovative use of various resource, online tools, and content to enhance learning (e-Books, Presentations, Multimedia, Podcast, etc.)

4.7 Sampling of Data

A purposive sample is the one whose characteristics are defined for a purpose that is relevant to the study. The study used purposive sampling. Andrade (2021) describes purposive sampling as a form of non-probability sampling where the researcher selectively chooses population based on the relevance of the characters to the study. The research study used ten grade 11 Mathematics teachers from five secondary schools as a population sample. The reason to conduct the study in five schools is that their 2018 to 2023 Mathematics results for grade 11 are below 75%, which is also still below the Provincial Education Department's target. Moreover, teachers in the five schools are currently using IWB to deliver Mathematics content. Grade 11 teachers are purposefully chosen to check their preparedness and attitudes around IWB usage. Also, Grade 11 teachers are believed to be knowledgeable about Mathematics content given that the syllabus covers grades ten, eleven and twelve content. These teachers are expected to teach Mathematics fundamentals to prepare learners for the next final grade, thus their selection was also purposeful. The population of the research study therefore consists of ten participants.

The researcher relied on the school principals to identify and extend the invitation to the relevant grade 11 Mathematics teachers. A consent form was made available to request teachers' participation in the study. Teacher information sheets were also made available to explain their participation in the research project through telephone. Both consent forms and teacher information sheets were emailed to the potential participants.

All ten grade 11 Mathematics teachers responded to questionnaires and interviews. The researcher used the sample to determine how IWBs are used in the mathematics department to enhance teaching and learning. The outcomes of the research helped the researcher to further explore teachers' practices when using IWB and evaluate their readiness and preparedness towards integrating IWB into the Mathematics curriculum.

4.8 Data Generation Instruments

The study used both qualitative and quantitative approaches to generate data through questionnaires and interviews. Each data generation technique had both qualitative and quantitative sheets. The use of different techniques to generate data is designed to ensure that there is consistency and clarity within the gathered data. The use of questionnaires made data generation economical and encouraged the anonymity of the participants. Issues relating to the preparedness and attitude of teachers which could have not been picked from the questionnaires were addressed during interviews. Interviews afforded the researcher direct interaction with participants, and they were able to express themselves broadly. Questionnaires and responses were exchanged through emails and interviews were done virtually through telephones. This made participants to respond to questions at their own convenient space and time.

4.8.1 Data generating techniques are briefly discussed below

Questionnaires

Questionnaires are instruments that are either structured or semi-structured used for data collection from respondents (Sukmawati, 2023). A common questionnaire was used as a technique to obtain information from participants. All Mathematics teachers responded to one common questionnaire. This made it possible to have uniform and consistent participation within the process (teachers responding to questions) and gathering adequate and relevant information from the participants. Both structured and semi-structured questionnaires were used to gather enough information about teachers' preparedness and attitudes towards effective integration of IWBs into teaching of grade 11 Mathematics content. The use of semi-structured questions enabled the researcher to gather enough data from the participants, while the structured questions helped in making comparison amongst the teachers. Moreover, the structured questions assisted in obtaining answers that are more focused on the research topic. Based on Sukmawati (2023), structured questions help to generate statistical analysis from responses. Participants had an opportunity to express their opinions through writing their perceptions about integrating IWBs and this helped in answering sub-question 2 of the research question which seeks to understand how teachers' attitudes affect the integration of IWBs in the teaching of Mathematics content in Grade 11. Through questionnaires, teachers could not feel like defending their answers or shifting blame on other people. Teachers were free and honest about their perceptions around IWB usage since human interference was minimal. Questionnaires were emailed to participants and brought back within three days. For those who did not complete questionnaires on time, an extra day was allocated to them. To enhance trustworthiness in the study, terminologies of abstract words such as Information and Communication Technology and IWB were explained to teachers for clarity purposes.

Interviews

The study used structured and semi-structured interviews to enable free response and provide explicit details. Interviews afforded the researcher an opportunity to have a conversation with the participants, asking questions and recording participants' responses. Through interviews, teachers' competencies were explained other than assuming whether they have skills around certain concepts. The interviews helped with answering sub-question 3 that focuses on the ways Mathematics teachers at Grade 11 using IWBs multimodal affordances to enhance their teaching and augment interactivity in mathematics classroom. Responses from interviews gave clear indication of skills and knowledge teachers possess when using IWB to teach Mathematics content. Through interviews, the researcher had a chance of giving clear description of concepts to avoid misunderstandings and uncertainties. To ensure that enough information is gathered from the participants, the researcher elicited information through probing the respondents. Probing in semi-structured interviews necessitates elicitation, elaboration for details, further explanations, and clarification of responses (Robinson, 2023). The structured interview ensures that responses are in accordance with set outcomes and help in ensuring that both the interviewer and interviewee stay focused on the interview process. Saarijärvi and Bratt (2021) acknowledge the advantages of interviews, but they also feel the interviewer might be intimidating which could make the situation uncomfortable for participants. Over and above that, Saarijärvi and Bratt (2021) insist that interviews have disadvantages, because they hold a potential for subjectivity. The interviewer might be biased and might have a higher cost and time-consuming nature and lack of anonymity. To eliminate the bias, the interviews ought to be used as neutral medium as possible through which information is shared (Robinson, 2023). During interviews, misconceptions and ambiguous concepts were cleared. In semi-structured interview questions, participants gave clear explanation about their experience of using IWB to teach Mathematics. Furthermore, the interviews provided a relaxed environment where participants gave rich and detailed information.

4.9 Data Analysis

Data was analysed using a parallel mixed method approach. Data analysis was generated separately from both qualitative and quantitative data drawn from questionnaires and interviews. Data generated from participants was coded and structured according to their similarity and differences. Similar data was shaded with same colours and arranged in a table. Patterns were then identified to generate connection between tables. Themes were then generated from similar codes. Data was then consolidated, reviewed and synthesis to produce four themes and sub themes. This is in line with Sukmawati's suggestion that analysing data in parallel mixed method research involves presenting data in a more structured and organised pattern where codes and themes are generated to make sense of participants' responses (2023). The research attempted to give detailed and rich data since data was generated from a small group of ten participants. The study used direct phrases to maintain authenticity. The generated data was refined accordingly, to avoid data overloading (Sukmawati, 2023). The quantitative analysis consists of tables and graphs that give a coherent data summary, and qualitative analysis has transcripts generated from participants' responses. A meta-inference was generated to merge the two analyses to generate a coherent and fully integrated analysis (Schoonenboom, 2022). Instead of using participants' real names, pseudonyms were assigned to individuals. Analysis of participants' responses collected from both structured and semi-structured questions was done based on the generated themes. Quantitative data was gathered, captured and analysed using data frequencies. A summary of qualitative data was aligned to the research sub-questions and themes.

4.10 Ethical Issues

In faculties where human beings participate in research, they must always be protected, and their anonymity must be maintained. The respect for their privacy must not be compromised and permission must be granted beforehand (Gregar, 2023). To comply with ethics requirements, a request was sent to Wits Ethics committee for clearance. The committee ensures that participants are protected, their rights are not compromised, and that privacy is maintained throughout the study. Before data can be collected, researchers need permission from participants and relevant authorities. For this study, a request was sent to the Provincial Education Department to be given permission to conduct the study in Tembisa schools. Upon the ethics committee granting the researcher ethics clearance (H21/03/31) and GDE's permission, a letter was sent to schools to request for their participation. Participants were identified by the school and the researcher presented a letter requesting their participation in the study. The researcher started engaging with the willing participants, after receiving ethics clearance, GDE approval and school approval letter.

The study's research topic, information sheet and consent forms were sent to the participants few days earlier to familiarise themselves with the study. Participants were made aware that participation in this study is voluntary, their anonymity will be maintained and that information provided will always remain confidential. Participants were further informed that they can withdraw from participating in the study at any time and they will not be victimised or suffer any loss. To maintain anonymity, the study used pseudonyms instead of their real names or school names.

4.11 Authenticity

The use of questionnaires ensured that participants are free to provide accurate and adequate information since they have different perceptions about the topic. Data results collected through instruments showed realities existing within the ICT enabled schools. To ensure that data triangulation and authenticity are achieved, the study used variety of data generation instruments. To maintain credibility and authenticity, interviews were conducted to avoid receiving incomplete questionnaires.

To maintain accuracy and consistency of the research findings, the study has applied relevant methodologies to ensure consistency and stability. The understanding here is that the methodological approaches applied in this study will remain unchanged over some time (Haq, Rasheed, Rashid & Akhter, 2023). From Creswell (2014) cited in Haq et al. (2023), the research's integrity rests on its validity and reliability. The researcher managed to remain neutral, apply credible approaches, conform and apply consistent research principles and produce results that could be dependable even if the study could be carried out several times (Haq et al., 2023). Remaining neutral throughout the research process has helped to generate fair results which signify that participants' responses remained pure and legitimate. The uses of different responses from both questionnaires and interviews assisted in maintaining triangulation and achieved trustworthiness within the study. To address validity, which is the integral form of trustworthiness, the researcher has produced a research plan which guided this research towards formulation and application of questionnaires, keeping neutral participation throughout interaction with participants and generating data analysis and interpretation without being biased.

4.12 Credibility

To contribute to the body of knowledge, researchers ought to produce a credible study. Research instruments used in this study such as questionnaires assisted to produce a credible, genuine and reliable data. Data collection instruments and data analysis strategies were used to facilitate the study's trustworthiness process. Authentic studies produce consistent results over time, therefore, the assumption in this study is that it will produce accurate and authentic results if the same methodology is applied. To further strengthen credibility, the study used more than one data instruments (questionnaire and interviews) which also assisted to maintain data triangulation. From Donkoh and Mensah's (2023) perspective, using various data generation instruments is a strategy for promoting the research's credibility and reality and it is classified as triangulation. The purpose is to gather rich information using many instruments to produce an extensive perspective of the problem. Unlike questionnaires, interviews encouraged social interaction, questions and answers that may be clearly explained in the case of ambiguity.

Interacting with participants during interviews allowed the researcher to unpack and clarify concepts in a much simpler manner. Interviews helped the researcher to guide participants to stick to the questions and stay relevant to the topic. Through probing and prompting, participants were able to give relevant and valuable information. The use of interviews enabled the researcher to assist participants to answer logically and ensure that important aspects of the questions are answered. Collecting data from participants from five different schools made the study to produce rich and authentic data.

4.13 Trustworthiness

To address issues of trustworthiness, the study has considered relevant aspects for both qualitative and quantitative research approaches and elements of trustworthiness were used interchangeably to cater for both approaches. Guba's model highlights trust, applicability, consistency, and neutrality as key aspects of trustworthiness for both qualitative and quantitative approaches (1981). Although there is a philosophical difference between the qualitative and quantitative approaches, different strategies are applied to test issues of trust worthiness (Haq et al., 2023). For example, in a quantitative study, truth is often determined by how well researchers manage threats to the study's internal validity. Lincoln and Guba (1985) regard truth as credible and that credibility is achieved by ensuring that the internal validity is measured through tangible reality.

Chapter 5 Data Analysis, Interpretation and Presentation

5.1 Introduction

This chapter presents data analysis, interpretation, and presentation of findings from semi-structured interviews and questionnaires from ten teachers in the Ekurhuleni North's township ICT secondary schools. A qualitative data analysis, interpretation and presentation will unfold before data could be analysed quantitatively. The study follows a mixed method research, so tables are used to summarise information that is deemed important. Data emanating from teachers' preparedness, attitudes and experience has been coded and grouped into themes and sub-themes. Both the themes and sub-themes have been carefully aligned to address the research questions. Even though all the themes do not link directly to the research questions, some themes address aspects of the main research question and the sub-questions.

A. Qualitative data analysis, interpretation, and presentation

The main question and sub-questions are reinstated below to show coherence with the themes and sub-themes. Themes and sub-themes are derived from data generated from interview questions and questionnaires. Below is table 5.3 showing a summary of Themes and Sub-themes. This is followed by a full account of each theme before discussing sub-themes.

5.2 Research questions

Main Question: How teachers' preparedness and attitudes affect the effectiveness of using the Multimodal Affordances of the Interactive Whiteboards into teaching of grade 11 Mathematics content?

Sub-questions: The following questions will help to provide answers to the main research question.

1. What links do Mathematics teachers make between multimodal affordances of Interactive Whiteboards and the constructivist-oriented practices in the teaching of Mathematics concepts at Grade 11?

2. What are teachers' attitudes that advance the integration of IWBs in the teaching of Mathematics content in Grade 11?

3. How do Grade 11 Mathematics teachers use IWBs' multimodal affordances to increase student–content, student–teacher, and student–student interaction in Mathematics classrooms?

5.3 Themes and sub themes

Data is presented, interpreted, and analysed based on the themes and sub-themes provided in table 5. The research has used direct citation to fully capture participants' responses. As previously mentioned in chapter 4, participants' full description, i.e., (GiyaniSAQ) is included at the end of each direct citation.

Table 5 Themes and Sub-Themes

Themes	**Sub-Themes**
Theme 1: Factors influencing IWB usage in teaching Mathematics content.	**Sub-Theme 1:** knowledge and skills of using IWB to teach Mathematics content. **Sub-Theme 2:** Teacher awareness of the IWB as a productive, time saver and easy tool to teach Mathematics classrooms **Sub-Theme 3:** Teacher's attitude towards teaching Mathematics content through IWB **Sub-Theme 4:** Teacher's experience of using IWB to teach Mathematics content (Referral, formal and informal training, trial and error)
Theme 2: Teaching strategies for Mathematics classrooms with IWB.	**Sub-Theme 1:** Digital pedagogies for Mathematics classrooms. **Sub-Theme 2:** Accommodating diverse learning experience in Mathematics classrooms. **Sub-Theme 3:** Promotion of learner-centeredness in Mathematics classrooms.
Theme 3: Constructivist-oriented practices in Mathematics classrooms with IWB.	**Sub-Theme** 1**:** Improve knowledge retention in Mathematics classrooms. **Sub-Theme 2:** Moving learners' knowledge from known to unknown during Mathematics lessons. **Sub-Theme** 3**:** Improve learner attention for active learning during Mathematics lessons.
Theme 4: The affordances of IWB augment interactivity in Mathematics classroom.	**Sub Theme 1:** IWB as an interactive tool in Mathematics classroom. **Sub Theme 2:** IWB as a collaborative tool in Mathematics classroom.

5.4 Theme 1: Factors influencing IWB usage in teaching Mathematics content

This theme discusses participants' views in relation to their understanding of factors that influence IWB usage. Participants' responses focused more on knowledge and skills, teacher attitude and teaching experience as influencers of IWB usage. These factors were identified as sub-themes and presented separately. The discussion within the sub-themes overlapped since they are interrelated. Apart from the sub-themes below, participants cited many factors that affect IWB usage, and they showed different understanding about these factors. However, in most of their responses, factors which are discussed as sub-themes were dominant.

The focus of the theme is to show how teachers are influenced by these factors in their daily usage of IWB classrooms. It assumes that technology acceptance or usage is driven by many factors; the context and content dictate how these technologies are used. Many researchers narrowed their technology adoption to examine the factors affecting the adoption and usage of IWB and various factors were identified and put according to priorities (Hassan, Amin & Ghoneim, 2024). This research has not prioritised these factors according to their order or degree of importance. However, it has used these factors which came from participants' responses to develop a theme and sub-themes.

5.4.1 Sub-Theme 1: Knowledge and skills of using IWB to teach mathematics content

Evidence from the questionnaire and interviews pointed out that access to IWB is not enough to determine usage of the device in Mathematics classrooms. However, without access, one cannot talk about usage. Therefore, access is an important aspect of ensuring that users can start utilising the resources. The ten participants acknowledge the importance of having access to IWB classrooms and they showed no limitation towards having access to these classrooms. Now that access to IWB classrooms was evident to all participants, the main question was whether they have the necessary knowledge and skills for utilising the IWB to teach Mathematics.

Participants acknowledge the presence of IWB in their teaching era and count themselves as fortunate teachers given that not all teachers have access to these resources. Participants mentioned the importance of having adequate knowledge and skills for integrating IWB in their Mathematics lessons. Without skills and knowledge, they acknowledge that it would be difficult to use IWB to teach. For instance, while responding to the questionnaire, the following comments were made:

> I possess the necessary skills and knowledge of using the board and have acquired them through training from the department. These were sharpened through constant interaction with the IWB and assistance from onsite trainers. I can manipulate information on the board to suit my Mathematics lesson. The technical skills that I possess help me to troubleshoot the IWB when it freezes. I use these skills to navigate the board and teach Mathematics without difficulties (SekhukhuneSEQ).

> My knowledge of using the board has improved with my teaching of Mathematics. Initially, my skills were lacking but with time, I managed to improve. I still struggle with initializing the board which I believe it is part of the technical skills that one should have in general. I have soft skills; I can switch between many applications and connect devices to the board. I can select and use relevant applications to teach Mathematics and for me, this makes my teaching to be simpler. Although there are many applications that one requires to use for teaching of Mathematics, I always strive to develop skills which will enable me to fully utilise them (MopaniSAQ).

> I have technical skills which are deemed necessary for teaching Mathematics using an IT device. I also know how to utilise the IWB to teach Mathematics. As a young teacher who is used to technology, I find it interesting to teach with it. I use the IWB for writing, presentation of slides and playing Mathematics content videos. I am using my ICT experience from fiddling with other devices to develop knowledge of adding Mathematics content to the IWB. My experience in ICT is helping to move Mathematics content from one board to the other without rewriting any notes (CapricornSCQ).

The user's knowledge and skills of using an ICT device such as IWB cannot be reduced to mere switching on and off the devices. Teachers require adequate knowledge and skills to fully integrate IWB into their Mathematics teaching. From Sekhukhune's perspective, manipulating information to suit lesson outcomes is key to IWB usage. Apart from moving and shifting resources around, Sekhukhune feels technical skills are important towards making sure that the IWB is always functional. Based on Sekhukhune's experience, technical skills are shared by constant interaction with the IWB. The assistance of onsite trainers is acknowledged hence Sekhukhune insists that her skills have improved from their assistance. What is evident from the participants is that they value technical skills more. This was picked from Mopani's response of failing to initialize the board during configuration. Mopani insists that with time, more skills are acquired and claims that technical skills are more important to technology users. Hence connecting of other devices to the IWB was regarded as an important process towards IWB usage. Mopani’s concern of constantly developing IWB skills can be equated to Sekhukhune’s response of sharpening her skills through constant interaction with the board and onsite trainer. This shows that the two participants value skills development and want to keep up with the ever-changing technologies. Mopani echoed the same sentiments and puts technological skills as a priority towards utilising a variety of applications for teaching Mathematics content.

Bardakci and Ünver (2020) acknowledge that there are various factors which contribute to poor usage of IWB especially in the United Kingdom where the roll-out of IWB is over 70 percent. The technical threshold is amongst other factors which hinders users to harness the opportunities that come with these resources (Bardakci & Ünver, 2020). Burke, Kearney, Schuck and Aubusson (2022) put technical factors amongst the first barriers of IWB usage especially in Mathematics lessons. For Burke et al. (2022), all external factors such as resources, access and professional development should first be addressed before internal factors including beliefs, pedagogical approaches and competency could be scrutinised.

Teachers are mediators of Mathematics content; their pedagogical knowledge will possibly influence how they teach in the classroom. However, if they lack technical skills and technological competencies, they are likely not to use or adopt any technology into their Mathematics lessons. Teachers’ adoption is influenced by their personal skills and experience of using technology. For Burke et al. (2022), adoption of technology can be higher only if teachers’ personal skills and experience on technology can be improved. Otherwise, this could result in teachers developing resistance to technological devices and negative syndrome which is regarded as resistance and attitude towards technology (Bardakci and Ünver, 2020).

Pedagogical knowledge is central to the teaching process within the school curriculum. A teacher is expected to have both content and pedagogical knowledge from his or her discipline. With technology gradually becoming inseparable from the classroom, a new knowledge known as Technological Pedagogical Content Knowledge (TPACK) is crucial for teachers’ practice (Moreno, Montoro & Colón, 2019). For Moreno, Montoro and Colón (2019), this is not concerned with mastering how to teach with technology but it a set of knowledge which “includes, for example, the knowledge of pedagogical strategies that allow the effective use of technologies to teach the content of the discipline, and the knowledge of the aspects that make the content easy or difficult to learn, and how technology can help with some of the problems that students face” (p.2). Therefore, teachers must possess this knowledge especially in this 21st century era where Mathematics content is distributed within many spheres of the learning platforms. Lai (2019) insists that teachers must not only be competent technology users, but they ought to back up their technological knowledge with correct pedagogies. Hassan et al. (2024) value pedagogical knowledge and insist that teachers should align this knowledge to the constructivist's way of teaching. For Hassan et al. (2024), such teachers are likely to adopt IWB into their teaching practice since they could use interactive tools which promote collaboration and communication. The affordances that are associated with IWB could benefit learners through teachers' pedagogic intervention and we could see learners' attention and concentration increasing in Mathematics classrooms (Lai, 2019).

It is interesting to see how Sekhukhune, Mopani and Capricorn value technical skills as a high contributor of IWB usage. However, despite similarities in the participants' responses that seem to argue for possession of technological skills, usage of these skills into their teaching practices seems to differ. For example, Sekhukhune suggests that technical skills are helpful for troubleshooting the IWB when it freezes, while Mopani emphasises the idea of switching between many applications and connecting devices to the IWB. Capricorn suggests that IWB is used for writing notes, presenting slides, and playing videos during Mathematics lessons. With reference to Sekhukhune and Mopani's responses, more emphasis is put on using technical skills for technical problems while Mopani's response seems to suggest that the technical skills are used for multimedia presentation.

Even though the three participants' responses emphasise the importance of technological skills towards usage of IWB, little is said about how technological skills are integrated with pedagogical skills. One cannot assume that a teacher with high technological skills would automatically integrate technology, Mathematics content, and pedagogy. Otherwise, we would be reducing TPACK knowledge into technological knowledge. Other participants' responses showed TPACK knowledge as a contributor to IWB usage. The responses below demonstrate how other participants understand how knowledge and skills contribute towards technology usage.

> I am knowledgeable about IWB software and have strategies of teaching Mathematics with technology. I also have computer literacy skills which enable me to teach Mathematics content easily. The skills helped me to plan and prepare Mathematics lessons for my learners. I present Mathematics lessons through IWB and use teaching strategies to expose learners to various multimedia content (GiyaniSAQ).

> I have skills and knowledge of teaching Mathematics using IWB, laptop, cell phone and tablets. Whenever I am using an ICT resource, I make sure that a digital teaching approach is used for my Mathematics lessons. My lessons become interesting because learners enjoy my teaching approach and lessons outcomes are easily met. Knowledge about educational applications accessed through IWB helps me link different sources and combine them to suit my lesson (ModimolleSEQ).

> As an ICT coordinator, I am techno survey, I have experience in using different gadgets for teaching purposes. I have accumulated knowledge on how to apply computer skills into Mathematics lessons. My teaching approach tallies with the ICT resources that I use to teach. I become a productive teacher since lessons are shared through IWB and learner tablets, without these knowledge and skills, I would not know how to teach using IWB and present lessons accordingly (LephalaleSBQ).

Giyani foregrounded the importance of applying knowledge and skills of IWB into teaching practice. It is important to note that computer skills are mentioned as contributors towards IWB usage. However, Giyani acknowledges that these skills are important to be integrated into Mathematics lessons. It is for these reasons that Giyani emphasises how teaching strategies are used in line with ICTs. Over and above, using IWB as a generic tool for teaching, Giyani explained the importance of presenting through multiple multimedia content and strategies accompanying those applications. Although it is unclear whether Giyani's 'good strategies' mean digital strategies, the response seeks to suggest that teaching strategies ought to match the resources used during lesson presentation. The response also suggests that, when using IWB and applying appropriate approaches, lesson outcomes are achieved. Depending on how one has planned and prepared their lesson, Giyani puts the use of ICT resources and teaching strategies at the forefront.

The value of technology and its ability to help teachers present Mathematics content better is emphasised. A similar view was shared by Modimolle, mentioning the importance of using a digital teaching approach which improves learners' interest towards Mathematics lessons. A combination of teaching strategy and ICT resources to deliver interesting content is highlighted at great length. Uses of various applications as additional resources are valued and appear to be enriching participant's lessons. What is coming out clear is that Modimolle utilises different resources and applications to extend Mathematics lesson scope. An emphasis is put on an approach that suits an ICT resource. What is not coming out clear is whether merging of technological resources to a teaching strategy equates to adequate mediation of Mathematics content knowledge.

Both Giyani and Modimolle seem to highlight the need to cooperate teaching strategies that suit a technological resource. Participants understand that their technological knowledge and skills should help them use any ICT resource to enhance their teaching of Mathematics. The art of using IWB's applications and multimedia content to teach is valued by both participants. However, participants agree that any software or subject content should be aligned to a teaching strategy.

Lephalale puts similar views on how knowledge and skills affect the use of IWB in Mathematics classrooms. The importance of having technical skills is highlighted and ICT resources are valued as productive tools for teaching and learning of Mathematics. Lephalale's response suggests that there is thorough selection of ICT resources before Mathematics lessons can be delivered. The idea of matching the teaching approach with the ICT resource implies that resources are selected and evaluated according to their affordances. The ability of sharing Mathematics content with learners, enables Lephalale to be productive. Content sharing ensures learner-content interaction and possibilities of surfing and comprehending for better understanding. Lepalale values the importance of accumulating adequate knowledge and skills for using ICT resources to teach Mathematics and feels that without them, it would be difficult to teach especially in IWB classrooms.

Participants also showed how ICT resources coupled with applications and multimedia enable them to present Mathematics content better. Even though participants' responses seem to show understanding of using technological knowledge and skills to teach Mathematics, it is unclear how their technological knowledge and skills are integrated with Mathematics content knowledge and pedagogical knowledge to deliver TPACK knowledge. What is surfacing from their responses is that an ICT resource should be correctly matched with a teaching approach during Mathematics lessons. Raygan and Moradkhani (2020) highlight the importance of teachers mastering the interaction between three components of the TPACK knowledge. Hsu, Liang, Chuang, Chai and Tsai (2020) put TPACK at the forefront of technology involvement in curriculum as it provides an interrelation between sets of knowledge. Even though Hsu et al. (2020) suggest that acquiring TPACK knowledge is not enough to determine technology usage, TPACK knowledge is placed within the formidable knowledge that is necessary for technology usage. A teacher might develop a positive attitude towards technology but if the teacher concerned does not possess TPACK knowledge, integration of technology into Mathematics content will be a disaster.

Research by Raygan and Moradkhani (2020) showed how teachers' TPACK level contributes to technology usage. Of course, Raygan and Moradkhani (2020) do not neglect other factors such as developing a positive attitude as an added factor to teachers' TPACK level. According to Raygan and

Moradkhani (2020), combination of these two aspects) contribute drastically to effective use of technology in the classroom. The significance of TPACK cannot be taken for granted since for teachers to excel in using technology, they must be knowledgeable about technology and its benefits. Otherwise, they would fail to use a tool or device because of skills shortage and poor integration skills. Maybe, that is why Mopani feels there is a need to improve and continue sharpening ICT skills for good usage of various technologies.

Teachers' practices reflect the application of technological tools during Mathematics lessons. It cannot be a coincidence that a teacher with TPACK would use technology correctly to teach Mathematics. The fact that Giyani is knowledgeable about IWB software and strategies of teaching with technology suggests that there are high possibilities of utilising IWB fully. For Ardıç (2021), teachers with average TPACK would use technology to the same level. However, they can build TPACK confidence as they interact with various technologies (Ardıç, 2021). This is evident with Lephalale's comment that using different gadgets for teaching mathematics, more knowledge is accumulated on how to teach with computers. As they develop confidence in using technology, they eventually become comfortable and start utilising it more frequently (Raygan & Moradkhani, 2020). This is in line with Ardıç's (2021) idea that "TPACK self-confidence of teachers who use more than one computer software in their teaching is significantly higher" and gets to improve as they continue to interact with computer software (p.14).

The responses from the above participants showed the need to equip teachers with necessary skills for technology usage. The introduction of IWB into Gauteng township secondary schools has shown the need for teachers to acquire adequate TPACK knowledge for utilisation purposes. As mentioned earlier, knowledge and skills does not guarantee usage, but it may serve as a stepping stone. It is not surprising that responses showed different opinions in relation to knowledge and skills needed for IWB usage. Even if ICT skills were mentioned as key influencers of IWB usage, participants emphasised their experience of using these skills to advance the teaching of Mathematics in their schools. Responses from participants showed a need to upgrade their skills to fully capacitate them with TPACK knowledge for better integration of IWB within Mathematics curriculum.

5.4.2 Sub-Theme 2: Teacher awareness of the IWB as a productive, time saver and easy tool to teach Mathematics classrooms

Studying teacher awareness allows the research to find out how participants value the use of a technology for teaching of Mathematics. Teachers are human and they are bound to develop different views around technology. Thus, regardless of having same knowledge or teaching experience, their interaction with technology is likely to be determined by how they view it. Hence Mokoena, Simelane-Mnisi, and Mji (2020) believe that people may share the same ideology or have the same principles, but they could agree or disagree on the same aspects. Usage of IWB by teachers would properly be different because of how they perceive it.

Considering the influence of teacher awareness towards IWB usage to teach Mathematics, participants viewed the IWB as a productive tool that saves time and makes lessons interesting. Participants praised the affordances of IWB and emphasised how it rescued them during Mathematics lessons. Even though participants had similar views of the IWB (saves time and is an easy tool to present content with), different practices were picked from their responses. Below are participants' views of the IWB as a teaching tool.

> Syllabus coverage in IWB enabled classrooms is faster as compared to classrooms where there are no IWBs. Informal assessment administered during Mathematics lessons such as class activities are displayed easier because they are instantly projected on the IWB's interface. Learners can quickly copy and paste presentations from the board into their personal devices. The use of IWB makes me productive because more focus is directed to teaching of Mathematics content other than drawing graphs that are not accurate and significant (MakhadoSDQ).

> If I am teaching graphs, it makes presentation much easier and understandable than when they are presented on the chalkboard. The use of tables and drawing sheets from IWB makes it easy for learners to understand how graphs are transposed and reflected. Creation of mirror images becomes easier, and learners show their understanding by drawing accurate graphs on the IWB. This ensures that what the teacher has taught in the classroom is valid and fruitful. Their quicker understanding works to the advantage of the teacher because syllabus can be covered easily going forward (VhembeSCQ).

> It is easy to complete your syllabus because you can navigate between Mathematics topics which are linked to one another. Because Mathematics content is saved on the board, it is easy to refer from previous lessons and for catch up purposes in cases where learners have forgotten the previous content (WaterbergSDQ).

> Using textbooks that are on the IWB, the teacher can present Mathematics content simpler since eBooks can be navigated with ease. Question papers can be presented together with

content simultaneously and these make learners relate with concepts much easier (MusinaSBQ).

In general, participants viewed IWB as a tool which can present Mathematics content simpler and faster. Participants seem to be in favour of IWB as compared to other technologies. Frequent navigation of the IWB and presenting Mathematics content with ease suggests that participants are comfortable to teach Mathematics using this technology. Participants' responses imply that there is high classroom interaction and learners seem to be benefitting from IWB presentations. Part of the benefits includes learners conceptualising Mathematics content better when the IWB is used. Moreover, the responses suggest that learners' construct knowledge easily since concepts are presented practically.

Makhado's instant projection of class activities tallies with Waterburg's response of referring learners from saved activities. Presenting Mathematics content instantly on the IWB implies that time is no longer wasted writing on the chalkboard. The explanation by Makhado that IWB helps with presentation of accurate graphs supports the idea of Mathematics content being presented efficiently and effectively. Otherwise, teachers were going to waste time drawing figures or diagrams which are not up to scale. Learners also benefit from the time factor since they get a chance to interact with content. This is in line with Vhembe's response that the IWB allows learners to translate what they have learned into diagrams that are more significant and precise. From Musina's perspective, teachers become productive when they use IWB to teach Mathematics. Hence the multiple presentation of Mathematics content through various mediums. Learners can cross reference information to validate their understanding based on Musina's views.

While Makhado, Vhembe and Musina acknowledge how learners conceptualise learning quicker when they are exposed to the IWB, Waterberg perceives the IWB as a tool that can accommodate learners who could not conceptualise Mathematics content instantly. For Waterberg, teachers can use the board for catch-up programme in case learners are not at par with the syllabus. The implication here is that Waterberg sees IWB as a scaffolder hence the idea of the IWB being used to refresh learners' memories.

In general, the IWB is regarded as a useful and easy technology to use for teaching and allows teachers to present rich content through multimedia. Mokoena et al. (2020) assert that the interactivity of the IWB makes teachers develop interest in using the IWB to teach. A teacher will value technological tools that make life easy provided the tool is not complicated. When such a tool is valued and perceived as easy and useful, there are many chances of being integrated into the lesson. Integration would possibly create new experiences, better approaches, and possibilities for learners (Samsonova, 2021). Hence Makhado and Vembe's responses show how IWB classrooms enhance their teaching and promote active learning in their Mathematics classrooms.

Mokoena et al. (2020) warn us about teachers who perceive IWB differently from the above respondents, such teachers would avoid using IWB or would use it as an ordinary chalkboard. Lack of innovation in using the IWB would cause teachers to spend their teaching time writing notes instead of presenting content differently (Mokoena et al., 2020). Such teachers will fail to use IWB creatively and passive learning would still prevail even in technology enhanced classrooms. It is important to note that responses from participants do not portray any sign of IWB being perceived negatively. Even though participants' IWB usage may differ according to the skills they possess, participants valued and saw the IWB as an easy and useful teaching tool. Hence, Waterburg and Musina believe that through IWB, syllabus completion becomes easy because of good access to Mathematics E-Books and previous question papers.

Teachers who regard IWB as a useful tool would likely use it to produce a fruitful and conducive learning environment where learners are highly engaged during lessons and supported where necessary (Samsonova, 2021). Karthigesu and Mohamad (2020) recommend features of the IWB since it caters for learners' various intelligences and learners' diversity does not become a stumbling block to learning. Of course, this can only be achieved through teachers' intervention and good usage of the IWB. Based on the participants' responses, available content on the IWB enables learners to switch between materials and develop a better perspective on Mathematics concepts. This is supported by Hence Lai (2019) who believes that "IWBs reinforce students' motivation and engagement in learning because the interactive features attract their attention and increase concentration" (p.511). Vhembe validates the idea that IWB increases concentration by citing how learners spend their time drawing graphs which are reflected and transposed.

Makhado sees the IWB as a productive tool which benefits both the teachers and learners. When learners spend less time writing notes, it means they have more time to interact with learning material. This is in accordance with Karthigesu and Mohamad's (2020) suggestion that learners-content relationship gets strengthened when they work with learning material. Learners' self-confidence and interest in Mathematics gets elevated as they interact with content knowledge (Karthigesu & Mohamad, 2020). Responses from participants demonstrate how IWB was used to improve access to teaching and learning resources. Participants found the IWB useful and helpful, their praises of IWB showed the excitement of using technology to teach Mathematics. Participants perceived the IWB as the most resourceful tool which promotes classroom engagement. In classrooms where technology is perceived useful, teachers are likely to use technology to encourage independent and innovative learning (Karthigesu & Mohamad, 2020).

Participants showed how IWB helps with saving time and providing opportunities for learning. It is interesting how participants presented different practices and experiences of using the IWB to enhance their teaching of Mathematics. Of course, usage of IWB cannot be influenced by a single factor. The discussion above provides evidence that participants' awareness has affected their way of teaching. However, other factors such as teacher attitude cannot be neglected when factors affecting technology usage are discussed. Below is a discussion of how teacher attitude affects IWB usage.

5.4.3 Sub-Theme 3: Teachers' attitude towards teaching mathematics content through IWB

Teachers are social-beings, and they carry along feelings and experiences through their interaction with the world. Teachers develop attitudes as they continue to face new innovations within the school curriculum. Teachers' attitude is not an exception when it comes to influencing teaching through IWB. For as long as teachers have different ages; perceptions and experiences of IWB, their attitude would differ tremendously. Based on Ardıç (2021), teachers' attitude is affected by both internal and external factors which change significantly according to users' interaction with technology. Examples of these factors include frequency of exposure to technological devices, nature of technology and users' judgements about technology use (Ardıç, 2021). With reference to participants' attitude to technology, below is how they responded to attitude questions.

> I am now more used to technology than before. Initially, I used to hate it because I felt it was a waste of time especially that I had to plan and prepare in advance. Since I am now used to the LED board, I work smart and easy. I have moved from a simple user to a frequent user of technology. I find the IWB effective and productive since more learners can participate with ease when I use the board because they would want to touch and move things around. The board helps us with objects that are not clearly visible in the Mathematics textbook. The touching and moving of objects make the Mathematics lesson to be more practical (MakhadoSDTI).

The IWB made me a more confident user since I am forced to teach Mathematics with the Interactive board. My presentation skills have improved because I do most of my presentations on PowerPoint slides. I now see technology as a must have tool since it has many opportunities. Learners like learning through digital devices. Most of my learning objectives are met since they become attentive. It also saves time and makes Mathematics lessons interesting (MusinaSBTI).

The use of IWB has deepened my skills of teaching Mathematics with technology. I always thought I could teach Mathematics well with any technology but features of the board made me more creative and innovative in terms of my teaching. Switching between applications and programmes without losing learners' focus requires a teacher with adequate skills and knowledge. Multi presentation of Mathematics lessons link different concepts, ideas and one can also play videos for enrichment. Slow learners are catered for since different styles of teaching are used to enhance learning. Nowadays, kids learn better using visuals because they are always on their phones, thus presenting Mathematics content through IWB makes it even simpler for them to learn (ModimolleSETI).

I am now more attached to using the IWB than chalkboard. I struggle a lot with classrooms that do not have IWB. This has shown me not to underestimate what technology can do. I teach Mathematics better with IWB; it is a must have tool for every class. I used to view technology as an add-on which one can do without but since I started using IWB, I am now clued to it. Instead of making copies, I easily present Mathematics content on the board using various platforms that includes MS applications. Learners are no longer copying notes, so my teaching becomes faster (CapriconSCTI).

I used to see less value in technology because of my skills' shortage. I used to think technology would distract my Mathematics lessons since learners will focus on technology rather than subject content. But with time, I realised the importance of technology in my teaching. I started achieving objectives quicker and my lessons started to become interactive. Technology enhances our teaching, and I find it more useful and easier since I have developed skills now. The interactivity of the board makes teaching of Mathematics practical and engaging. Lesson presentations can be sequenced better with IWB, and teaching is not delayed due to compiling of notes or diagrams (MopaniSFTI).

It is interesting to see how teachers' experience around IWB has influenced their attitude to technology. What is dominating from participants' responses is their initial perceptions around IWB being a time-consuming tool. However, their experience has made them aware of opportunities that come with the

IWB. Most regard IWB as a must have technology due to its nature of bringing collaboration, communication, and interaction. Makhado sees the IWB as an effective and productive tool which promotes learner participation. Even though Makhado felt IWB wastes time because of the demand to plan and prepare content presentation, a different perception was developed upon using the IWB frequently. It is evident from Makhado's assertions that the IWB is helpful since it eases the workload and makes Mathematics lessons more meaningful and practical. Considering Makhado's age (52 years), it is understandable that the usage of the IWB was not as frequent as it is now. Hence, the IWB was regarded as a time-consuming tool. With time, Makhado became a frequent user and developed skills of utilising the IWB effectively.

The idea of IWB being a must have technology shows the positive attitude Musina has on technology. Looking at the number of years of teaching using IWB, the frequent usage has made Musina a confident IWB user. The participant sees IWB carrying opportunities which help the achievement of lesson objectives. Musina is in favour of the IWB because it saves teaching time and makes Mathematics lessons interesting. Evidence by Modimolle suggests that there was an assumption that technology is simple and can be taken to the classroom without any preparation. Modimolle thought technologies are just plug and play teaching tools. With time, the participant realised the importance of analysing features of the IWB to improve and match the teaching strategies. The response implies that IWB has affordances which ought to be used to enhance teaching and make learning more meaningful. Modimolle puts forward possibilities that enable learners to achieve when they are taught in IWB classrooms. For Modimolle, IWB should be used innovatively through correct teaching strategies so that learners are not lost in the process.

Capricorn shares the same sentiments with Modimolle by highlighting that a user should not underestimate technology. Capricorn's initial perception of technology being an add-on shows how the experience of using IWB has improved participant's perception. Now the participant feels that Mathematics classrooms without technologies are the most difficult to work with. Capricorn's attitude to IWB has created a dependency mind set, since he now sees IWB as a must have tool. For Capricorn, IWB helps to mediate Mathematics content hence presentation and sharing of Mathematics content are cited as examples.

Contrary to Capricorn, Modimolle and Makhado perceived technology as having opportunities before they could use IWB. On the other hand, Mopani's initial perception of technology was that of a destructive tool especially if it is brought into Mathematics classroom. The concern was that learners will focus more on the technology than the Mathematics content. However, with time, Mopane's perception changed, and technology was then adopted and integrated within the subject. From there, Mopani insists that the IWB helped to bring more interaction and made teaching of Mathematics more practical and appealing. Mopane's perception changed gradually and started to perceive IWB as a technology that afforded teachers a chance to structure Mathematics content based on the lesson's requirements.

Lack of access to technology, especially IWB, made Mopani think technology will bring destruction in the Mathematics classrooms. For Ardıç (2021)**,** access to technology is one of the external factors which contributes to the development of negative attitudes to technological tools. Even though attitude is regarded as an internal factor, Ardıç (2021) insists that external factors should be eliminated to focus on human factors such as perceptions and attitude. Otherwise, it would be difficult to judge one's attitude if he or she does not have access to technology. Attitude is seen as a predictor of technological usage and development of teaching competencies which involves technology integration (Ardıç 2021). Developing a positive attitude is an underpinning process towards eliminating barriers to technology usage (Regan, Evmenova, Sacco, Schwartzer, Chirinos & Hughes, 2019). Thus, teachers with a positive attitude to technology would highly use technology to teach. Musina's comment that 'IWB is a must have tool' could be used as a good example of a teacher with a positive attitude towards technology.

Lai (2019) suggests that teachers should know and understand what the IWB can do for them before they could start using it. Knowing the IWB's affordances and that the tool would be easy to use will make teachers develop a positive attitude towards the tool. This is in line with Marbán and Mulenga's (2019) argument that "attitude towards technology use is jointly determined by perceived usefulness and perceived ease of use" (255). Capricorn commended the IWB because it makes teaching faster and brings along lot of opportunities. Drawing from the participant's initial perception about IWB, one would notice that attitude towards technology has changed positively over time. This is supported by Ardıç (2021) who argues that teachers' attitude towards technology can be equated to their usage level. Those with a positive attitude would integrate ICTs higher than those with a negative attitude (Marbán & Mulenga, 2019).

Drawing from the UTAUT model, it is important to note that the behavioural intentions is influenced by both perceived usefulness and perceived ease of use (Lai, 2019). The two are known to be influencing the user's attitude as outlined from the TAM model. From Marbán and Mulenga's (2019) observation, the user's attitude to technology is determined by the perception of technology's value towards the lesson and how easy would the technology be when it is used to teach. And this will in turn determine if there would be adoption and integration of such a technology. Teachers who perceive technology as useful and having a positive attitude would develop interest in using technology (Lai, 2019). Their interest would push them to the actual usage of technology. Mopani's response of realising the importance of technology and finding it useful, easy, and realising the importance of technology in teaching Mathematics demonstrates how participants moved from perceiving IWB useful and easy to developing high interest in using the tool and finally use it.

There is no doubt that user attitude impacts heavily on technology usage (Regan et al., 2019). Before users can adopt or use technology, Marbán and Mulenga (2019) suggest that users ought to first shape their attitudes. A negative attitude would result in poor integration and mismatching practices which could result in technology being a disruptor of the lesson. The study by Ardıç (2021) revealed how the positive attitude of Mathematics teachers showed significant improvement on technology usage during lessons. Ardıç (2021) noted different factors which contributed to technology usage, however, attitude to technology usage remained prevalent and significant.

Participants' intentions to use the IWB and perceptions have influenced their experiences and practices outlined in their responses. Of course, their practices and experiences were equally influenced by their attitude. Taking cognisance of all factors which influence technology usage, Marbán and Mulenga (2019) rate attitude as the most pointer of technology usage. Drawing responses from Capricorn, Modimolle, Makhado and Mopani, their experiences and practices are different. With time, they eventually developed positive attitudes towards IWB. Even though participants might differ according to the integration level, responses show a fair utilisation of IWB as a teaching tool in Mathematics classrooms.

5.4.4 Sub-Theme 4: Teacher's experience of using IWB to teach Mathematics content

This section presents different views about participants' experiences of using IWB to teach Mathematics content. It is important to note that even if participants may have equal exposure to the IWB, their experience will differ tremendously because of various factors. Their knowledge, skill, attitude and views towards the IWB would influence how participants gather experience in classrooms. Researchers have found correlation between the adoption of technology and teaching experience (Gonzales & Gonzales, 2021). Those who are frequently using technology would gather enough experience and adopt it much easier than less frequent ones (Gonzales & Gonzales, 2021). The assumption here is that those with more experience would see value in the tool and utilise it to enhance their teaching. On the other hand, teachers with less experience of using ICT tool to teach could be using the ICT tool better than the experienced teachers. The opposite could also be true, hence participants argued that experience is relative. Participants presented different experiences and ways in which they gathered experience through interacting with IWB.

> My experience of using the IWB to teach is over 2 years and it has helped me present Mathematics topics much faster than before. Through formal training, I managed to gain skills for operating the board. Initially, I struggled locating resources and navigating through the IWB. Currently, I can align objects and link pages on the board according to lesson outcomes. To enrich learners' knowledge, I present notes, textbooks, and multimedia pages interchangeably (VembeSHQ).

> I used the IWB to teach for over 3 years thus far. My basic computer skills and training on IWB provided by the GDE smoothed the frequent use of the IWB. My planning is to improve steadily as years progress. Application of approaches that complement the use of IWB is gradually brought into Mathematics lessons. Through my experience of using the IWB, I can design simple presentations which are loaded on the board and present them in all classrooms with IWB. Pictures and videos broaden my teaching scope (MusinaSBQ).

> My IWB experience is more than 10 years, and I have used various applications to teach through smartboard. Presentations are aligned to available gallery and multimedia content which facilitate active learning. Through constant development programs from the department, my teaching practices are improving especially in Mathematics. My experience of using the smartboard allows me to explore and learn new things through fiddling and trying new things (LephalaleSBQ).

> I have vast experience in the education sector, and I have worked with ICT resources in many forms for more than 9 years. I used different interactive boards to teach, and I became knowledgeable as I gained experience. The IWB's features are used in conjunction with learning materials to improve presentation of materials. The IWB's multimodality allows inclusivity and caters for diversity in any Mathematics classroom. Apart from the IWB training that was exposed to us, I learnt to develop myself through trial-and-error methods. I am now mastering most applications and tools found on IWB (GiyaniSAQ).

With reference to participants' responses, one would notice that their experiences differ according to the number of years they have been using the board. It is also important to note that throughout participants' years of experience, the IWB was used differently to achieve lesson objectives. Even though participants used their number of years of teaching experience as their experience, they possibly had different amounts of time to access the board. Vhembe's teaching experience shows that the participant is new in the education sector and has less experience of using technological tools for teaching. Participants with fewer teaching experience, such as Vhembe and Musina proved to be having lesser experience of using IWB to teach. As years of experience increase, most participants seem to have accumulated experience in using IWB. At secondary school level, there are tendencies of maintaining the same teachers in the FET band especially if they are producing good results. Due to the Paperless Classroom solution being administered mainly in the FET band, mostly grade 11 and 12 teachers would be more exposed to IWB than others. Lephalale and Giyani are good examples since they both have over ten years of teaching experience and their IWB teaching experience is also around these years.

Participants acknowledge the GDE's efforts of developing teachers through IWB training. Vhembe insisted that the training came in handy since navigating the board was difficult. With time, Vhembe became a confident user of the IWB especially that there was frequent usage of the IWB. On the other side, Musina believes training coupled with computer skills contributed towards integrating the IWB into subject content. Gradually, Musina started developing presentations and aligning them to correct digital strategies. It is evident that Lephalale's experience made a huge impact in the way the IWB is used in the classroom. From the response, Lephalale cited couple content platforms used for teaching and learning. Lephalale's experience of using the IWB to teach facilitates active and innovative learning. Even though Lephalale agrees with other participants that training equips users with IWB skills, the participant believes in fiddling and trying new ways of teaching Mathematics through IWB. This shows confidence and ability to learn and explore things on their own. The same sentiments were echoed by Giyani who has over ten years of teaching experience and being knowledgeable about teaching with ICT resources. Giyani explains how trial and error strategy improved how IWB applications were used for teaching. Participants' responses show different ways of accumulating IWB experience. Even though they all received IWB training, their accumulation of experience as they continued using the IWB varied significantly. Some relied on the skill from training while others roped in personal development strategies which involved self-training and exploration.

It is interesting how participants valued their IWB experience and commended the application of their experience into classroom teaching. Vhembe explains how aligning objects and pages helps towards aching lesson outcomes. Musina's comment complements that of Vhembe because designing of eloquent presentations according to Musina is only possible if one has enough experience. Zooming into the experience of using the IWB of the two participants, one would notice that even with their little experience, they seem to be integrating the IWB with subject content effectively. Both participants enrich their teaching with multimedia which has possibilities of bringing active learner concentration and participation. On the other hand, those with huge experience like Giyani and Lephalale recommend experience to use IWB to mediate Mathematics content. Lephalale values how IWB caters for diversity and inclusivity in the classroom. Without adequate experience of using the IWB to teach, one cannot fully harness the affordances of IWB to improve teaching in the classroom.

The experience of using technology would always affect how they are integrated with lessons (Bonafini & Lee, 2021). There is a distinction between how experienced and inexperienced technology users would integrate ICTs into teaching (Bonafini & Lee, 2021). The assumption is, those with high technology experience would probably be comfortable around IWB and use them meaningfully and innovatively. And those with lesser technology experience are expected to suffer from poor integration skills. However, participants in this study have shown that technology experience alone is not enough to gauge technology integration. Giyani and Lephalale recommend their teaching experience and claimed it has contributed towards technology integration but other participants like Musina and Vhembe with lower teaching experience have also seen to be integrating technology like those with higher teaching experience. Mathematics classroom practice of teachers who fully integrate IWB would include good pedagogical strategies that promote an active learning environment. Therefore, their ICT integration would be more dependable on the Technological and Pedagogical Content Knowledge they possess other than mere technological experience.

When IWB are not used well, they could interrupt teaching and lead to a chaotic learning environment (Gonzales & Gonzales, 2021). Even though experience is questioned in this regard, one would suggest that those with no experience of using IWB might pose a risk of having poor classroom management and fewer chances of coming out victorious in their approaches. Vhembe's initial struggle of locating resources on the IWB portrays the inexperience of the participants in managing and integrating applications into the lesson. Even though the participant gradually used resources for teaching, it is evident that little experience was gained as years went by. Teaching experience of using technology alone cannot be equated to be the only factor to technology usage. From Samsonova (2021)'s perspective, teaching experience of using technology affects how users develop an attitude towards technology. Those with higher teaching experience would most probably hold a high positive attitude towards the technology. It is suspected that those with less teaching experience of using technology would highly have technical and pedagogical challenges which may result in poor usage of technology, but there are instances where experienced users of technology still fumble in using the same technology to teach.

Another key finding about IWB usage was how young teachers find IWB useful as compared to old teachers. Studies by Trujillo-Torres, Hossein-Mohand, Gómez-García, Hossein-Mohand, and Cáceres-Reche (2020) put young teachers as favourites on using technology to teach. The reason young teachers are favourites is that most of them are techno-survey and have experience of using technologies outside the education space. What Trujillo-Torres et al. (2020) suggest though is that "teaching experience is associated with the use of effective teaching methodologies and integration of technologies" (p.11). If young teachers cannot integrate their ICT skills into subject content, one might assume they lack experience of teaching using IWB.

In most instances, teachers' whose teaching experience is higher especially those closer to retirement, are seen as poor integrators of technology than young teachers. However, with reference to this theme, which focuses on teaching experience of using the technology (IWB) to teach, it has come out clear that experience of using the technological tool is more important than the general teaching experience. Hence, Gonzales and Gonzales (2021) believe that teaching experience of using technology contributes positively to how users perceive and integrate technology into their lessons. Furthermore, participants in this study proved that integration of technologies is not only dependable on experience only. That is why those with less experience of using technology were matching those with higher integration experience.

5.5 Theme 2: Teaching strategies for Mathematics classrooms with IWB

In this theme, I present what participants brought out as key aspects of teaching strategies for Mathematics classrooms with IWB. The responses reveal the importance of incorporating correct strategies for teaching Mathematics concepts in IWB enabled classrooms. The findings reveal that if teaching strategies do not match the teaching tools, then there would be poor classroom practices, and the technological tools could be disruptive. This would defeat the idea of endorsing ICTs and ensuring that it enhances teaching in the classroom. The responses further clarify how the adoption of the IWB has affected their teaching strategies. Many have acknowledged the changes in their teaching approaches and commended the IWB's multimodal affordances for presenting enormous programmes or platforms. During one-on-one interviews, participants explained how the following aspects have high significance to teaching strategies for IWB enabled classrooms.

5.5.1 Sub-Theme 1: Digital pedagogies for Mathematics classrooms

The importance of using correct pedagogies for IWB classrooms cannot be overemphasized. Every Mathematics classroom set-up has its own dynamics therefore pedagogy choice is dependent on the classroom setting. A strategy is deemed effective if it addresses the classroom context. A contemporary technology would not require old fashion strategy. Thus, technological tools used in classrooms should be accompanied by teaching strategies that are in turn integrated with subject content. Participants highlighted many pedagogic strategies which helped them to teach Mathematics using IWB. The use of digital pedagogies for IWB enabled classroom was dominant in their responses. Participants raised interesting views about how the IWB has affected their teaching strategy during the Mathematics lessons. Their views are as follows:

> I will have to plan how to navigate through resources that are on the IWB. Content verification becomes key since in your planning, you also check if the content you will be presenting is relevant. Juggling between programmes makes your teaching strategy diverse. It forces teachers to plan because you must know where Mathematics eBooks are located on the board. Otherwise, you will spend your teaching time trying to locate resources. Through planning, one can structure how Mathematics lesson could be delivered. Teaching slides are structured according to the lesson plan (MakhadoSDTI).

> It has enhanced my teaching strategy. Since teachers use different sources on the content, your knowledge expands, and you become a better knowledge presenter. Your way of explaining Mathematics concepts becomes clearer and simpler. Instead of writing everything on the board, you can just play an online video that explains the same concept. You can always emphasise important things from the video. Questions and comments can be posed in the middle of the video (ModimolleSETI).

> It improves my teaching strategy because planning and presentation of Mathematics content becomes easier in a sense that content planning is done on time and presentation becomes quicker. Handwriting is no longer an issue with IWB since it can convert handwriting into a typed text. Learners won't struggle to see the teacher's handwriting on the IWB. If videos are used, the voice can be increased, paused and replayed. Teachers can record themselves and the same

> recordings can be used for revision and in areas where they did not understand. There is less time on writing content on the board. With IWB, you can access textbooks and present prepared notes with ease (WaterbergSDTI).
>
> My teaching approach includes presentation of embedding text and diagrams that would be impossible to do without it. Fonts and drawings can be enlarged for learners to see what is on the IWB. Free drawing limits your ability to explain and expand Mathematics content accordingly (SekhukhuneSETI).

All participants acknowledged the affordances of IWB and explained how they have leveraged them to present Mathematics content differently. Use of different platforms on the IWB made it possible for participants to develop teaching approaches that are aligned to specific tools or programmes. However, before teachers can start utilising the IWB, participants emphasised the importance of thorough planning and preparation. What is not clear so far is whether teachers who are failing to use IWB could attribute that to poor planning and preparation.

Makhado's view of juggling between programmes indicates how various forms of teaching platforms are used to enhance teaching. However, what remains unclear is whether these programmes are aligned to digital pedagogies. Makhado further claims that the use of multi programmes to teach Mathematics in IWB enhanced classroom allows teachers to use diverse teaching strategies. Structuring of lessons and resources according to the lesson plan came out more significant to Makhado's comments. There is uncertainty on whether planning alone would result in the use of digital pedagogy. What is promising is that, through their planning, they can identify what could be relevant for their classroom situation, including teaching strategies.

According to Modimolle, those who use multiple sources for teaching have chances of expanding their knowledge and becoming good presenters. Interacting with different sources puts teachers at an advantage because strategies of presenting are mapped according to classroom requirements and practices. Modimolle described how a video could help in putting forward practical explanations of concepts. Such experiences require a teacher who would know when and how to use the video for teaching. Playing a video in class does not equate to application of digital strategy. Therefore, teachers should not assume that their teaching strategies are always digital in every technology enhanced classroom. According to Samsonova (2019), classroom technologies should be connected to pedagogies which address learners' needs. Applying a compatible teaching strategy which supports mediation of digital content appears to be key to contemporary teaching.

Waterberg explains the importance of shifting from a traditional chalk and talk teaching strategy to an interactive digital strategy. Incorporation of multimedia requires innovation and teaching approach that is engaging and learner centred. Waterberg holds the view that IWB lessen teacher dominance and allows learners to interact with learning material. On the other hand, Sekhukhune explained how teaching strategies are aligned to the IWB's embedded diagrams. The participant expressed the view that without IWB, it would be impossible to present Mathematics content practically. It is equally important to note that presenting Mathematics content through IWB requires a teaching approach which will make Mathematics content meaningful. Teachers who apply adequate teaching approaches aligned to Mathematics content, would eliminate misunderstanding and misconceptions of concepts.

The efficient and effective use of technology rests with the teacher's ability to use it to meet lesson objectives and address classroom needs. To fully integrate ICTs in the classroom, technology should be accompanied by digital pedagogy. However, Anderson (2020) cautions teachers not to reduce digital pedagogy to pure technological tools but as a means of mediating learning processes and connections with technology. Although digital pedagogy is not entirely about technology, it recognises technology as an effective and productive teaching tool (Anderson, 2020). Waterberg's approach of recording lessons and using them for revision serves as an innovative way of using technology and digital pedagogy to teach Mathematics concepts. Based on Waterberg's explanation, less time is spent on writing but more on watching videos and explaining to learners where they experience challenges. Whenever digital pedagogy is correctly implemented, regardless of how diverse the class is, their needs are likely to be met.

Bringing new innovations into the classroom does not imply complete scrapping out of the traditional face to face teaching. The evolving technology requires teachers who are ready and have skills to teach using these tools. Yu (2020) suggests that teachers should keep up to date with technological developments since they are useful for classroom practices. This is further supported by Rayna and Striukova (2021) who argue for self-development since most teachers are used to printed materials. The era of hard copies has passed and a digital era which requires innovative and progressive approaches has arrived (Rayna & Striukova, 2021). Web pages and online resources are recently used for teaching. In Waterberg's class, textbooks and online notes were presented through IWB. The assumption again is that Waterburg mediated content using digital strategy because different online sources were used, and these sources made explanation simpler and clearer.

With IWB having rich affordances, it is evident that teachers who do not possess skills of using them would replicate the chalk and talk into IWB classrooms. Samsonova (2019) inspires those with IWB in their classroom because of its abilities to facilitate learner-centred approach. Modimolle's experience of playing videos and juggling between programmes which makes his teaching strategy diverse confirms less teacher dominance during the lesson. Even though learner dominance is important, it is also important for teachers to direct discussions and pose questions where necessary. This was evident with Modimolle's situation since online videos were stopped while playing to check their understanding.

Evidence from participants' responses shows that various online and offline sources were used to enhance teaching. Participants' responses confirm the use of learning platforms and material which made their lessons to be fruitful. Most of the participants recommended presenting on IWB because it made their way of presenting lessons to improve. This suggests that participants were not applying good strategies in the earlier days of using the IWB, but as time progressed, they improved.

5.5.2 Sub-Theme 2: Accommodating diverse learning experience in Mathematics classrooms

During one-on-one interviews, participants appreciated how diverse learning experiences were accommodated using IWB. The complexity of dealing with learners having different intellectual abilities and preferred learning styles is a nightmare to many schools. Every learner comprehends knowledge differently thus it is the duty of the teachers to facilitate learners' knowledge construction through tools that are in their disposal. Recently, technological tools were used by many teachers to manage and mediate Mathematics content for various classroom contexts. In this study, participants maintained the idea that without IWB, other learning experiences would be difficult to manage. Practical examples on how the IWB was used to accommodate diverse learning experience were emphasised. For instance, during one-on-one interview with participants, the following remarks were made:

> Even slow learners can develop understanding from mathematical diagrams and pictures. Verbal explanations make it difficult for learners to grasp knowledge. Step by step graphical representation of Mathematics concepts helps in building knowledge. Multimodality of the board makes learning to be diverse and interesting. Those with hearing deficiency would mainly rely on pictures and those with poor eyesight would rely on voices and audios. Diagrams and graphs (for all types of graphs; whether exponential, parabola, hyperbola, etc) drawn from the

> IWB saves time, more time can be spent on emphasising important concepts since drawing of graphs is done with ease. As a teacher, I get more time to concentrate on the ones that have not grasped Mathematics content (GiyaniSATI).
>
> There are different types of learners; some would benefit more through visuals while others benefit from audio, text and graphs. Through practical explanation of Mathematics concepts, learners internalize concepts better and even abstract concepts are easily understood. An example can be drawn from a Geogebra software, where graphs can be manipulated to explain various aspects of the lesson. By seeing what is happening during the lesson presentation, they can retain knowledge better other than always listening to the teacher. Through recorded lessons, learners with diverse learning experience can learn at their own pace and form (MopaniSATI).
>
> I use different activities and methods of teaching using IWB. Through audio visuals, auditory learners are accommodated. It also helps with self-paced activities since learners are encouraged to stick to time. Slow learners adjust their pace by improving from their previous experience. The ones that can finish quickly can also improve to beat their previous times. Towards the end of the lesson, learners who are struggling can revise or catch up on topics that were not understood through video and recorded lessons. The teacher can use extra material to assist learners with special needs (SekhukhuneSETI).

Responses from participants highlighted different dimensions of their classroom situations. Participants emphasised that learning comprehension happens at different rates. There are slow, average and faster learners in terms of knowledge comprehension in every class. Preference of learning styles also differs; there are those who prefer to study alone while others prefer studying in a group. Some learners prefer visual or audio while others might prefer text. Learning experiences vary endlessly, however, what is important is how we manage them and help learners achieve within these experiences. Evidence from Giyani shows cases of slow learners being accommodated through IWB. The use of multimedia and teaching strategies which scaffold learners from basic to advanced level is recommended by Giyani. Hearing and eyesight deficiencies are catered for through IWB. Upon diagnosing learners' problems, Giyani devotes more time to struggling learners and uses necessary IWB programmes to assist them.

Mopani differentiates ways in which learners comprehend subject content in IWB enabled classrooms. Emphasis is put on the ability of the IWB to produce practical exercises which assist learners to internalise Mathematics concepts and formulate meaningful knowledge. Based on Mopani's response, in any teaching experience, learners should be able to retain knowledge successfully. A special programme - Geogebra - was used to generate and manipulate graphs which assisted learners to retain knowledge better. From Sekhukhune's perspective, IWB were used differently to accommodate learners' learning experiences. The self-paced activities were recommended to have assisted to accommodate both fast and slow-paced learners. Learners are competing against their records and intend to beat their previous records. This instils motivation and self-enthusiasm since learners always reflect on their achievement and failures to build on their future activities or plans. According to Sekhukhune's response, struggling learners were supported through remedial systems which seek to bring every learner on board. Following participants' responses, it is evident that the IWB was used in multiple ways to accommodate learners' needs. Based on the classroom context, focus was put on how the IWB could be used to instil Mathematics knowledge without discriminating against anyone regardless of their comprehension level, intelligence or skills.

Divya (2023) recommends the use of IWB because of its influence to trigger positive learning in the classroom. In classrooms where there is a high learning vibe, academic achievement becomes a prominent experience for learners. However, the multicultural and diversity of learners make it difficult to achieve learning outcomes. Using IWB could help to cater different characters in the classroom; the IWB's multimodality stimulates classroom interactions and may also help in promoting flexibility amongst learners and teachers (Bourbour, 2020). The flexible atmosphere creates a conducive environment with possibilities of high academic learner achievements in Mathematics. A conducive environment is depicted in Mopani's response that suggests how recorded lessons are used by learners to learn at their own pace, form and space. This on its own promotes diverse learning experience since learners are not restricted to the teacher's pace and one form of learning.

The IWB's storage affordance is recommended by Bourbour (2020) since content can be stored and retrieved with ease. Learning and teaching materials which could benefit learners at any given time can be accessible to them when it is necessary. These materials could come in different forms such as text, multimedia, online and offline content (Bourbour, 2020). Sekhukhune values IWB because it affords learners an opportunity to catch up on topics which were not understood through video and recorded lessons. Those who are struggling can revise or catch up on through extra material especially if they are needy learners. Providing extra content and multimedia content to the entire Mathematics class aims to accommodate the multi-diverse learning cultures existing amongst learners. From Giyani's perspective, the IWB supports learners with hearing deficiency through graphics (diagrams, pictures, etc.) and those with poor eyesight would rely on voices and audios. Diagrams and graphs (exponential, parabola, hyperbola, etc.) drawn from the IWB, give a better projection and clear dimensions. If graphs are drawn from the scale using IWB, more time will be devoted to explaining and interpreting the graphs. This is in line with Mopani's suggestion of investing in IWB since it provides opportunities for practical presentation of Mathematics concepts which promote internalisation of concepts by learners.

The research by Karthigesu and Mohamad (2020) substantiates the notion that the IWB provides learners "with resourceful learning experience which increased their excitement to learn, enhanced their classroom engagement and encouraged independent learning" (p.737). The IWB affords learners opportunities to discuss and negotiate meaning from a wide range of content and programmes. Teachers should use the IWB innovatively because it has the potential of producing a vibrant learning experience (Samsonova, 2021). Learners benefitting from IWB enhanced classrooms make huge progress with their social interaction and academic achievements in Mathematics. The social constructivist theory argues for learners acquiring knowledge through social interaction which is commonly found in IWB enabled classrooms (Shi, Zhang, Yang & Yang, 2021). The importance of bringing technology in the classroom is to mediate Mathematics content better and accommodate learning experiences which could not be catered for without technology.

The presence of IWB also fosters the notion of good representation of Mathematics concepts and ensuring that no learner is left behind in terms of comprehension. Sekhukhune's response of using the IWB to develop self-paced activities which encourages learners to stick to time is a good example of leaving no learner behind. According to Sekhukhune, those who are slow learners will adjust their pace by improving from their previous experience and faster learners will improve by beating their previous times record. Responses from participants demonstrated various learning experiences and ways in which the IWB helped in accommodating those experiences. Participants demonstrated how different learning preferences, environmental dynamics and pedagogical experiences were dealt with through utilising IWB to teach Mathematics.

5.5.3 Sub-Theme 3: Promotion of learner-centeredness in Mathematics classrooms

This sub-theme focuses on how IWB is used to promote a learner-centred teaching approach. Participants expressed different views on how their daily practices encourage learner dominance during Mathematics lessons. Both technical and pedagogical practices were used to ensure that there is high learner engagement in the classroom. Despite evidence of IWB integration, classroom practices differed based on the learner-learner interaction. Response from participants showed application of various teaching strategies which support high involvement of learners in IWB classrooms. Participants provided examples of how IWB applications and programmes were used to solve mathematical problems. Responses from participants suggest the following:

> By connecting IWB with learners' cell phones or tablets, learners' answers will be reflected on the board. Results from the board will promote competition and the teacher will deal with errors or misconceptions in the classroom. Giving learners a chance to work on their own ensures active participation. Learners will be more engaged in solving Mathematics problems other than listening to the teacher. By linking the board with learners' devices, it helps you to track learners who are slow and deal with their problems immediately LephalaleSBTI.
>
> By exposing them to audio visuals, it will make them take note of important aspects and later discuss Mathematics content that has been presented. The teacher monitors and facilitates the discussions about the presented content. Learners would give their views from the discussion, either in groups or individually CapricornSCTI.
>
> I normally start my lessons with videos to trigger their interest. Later, I pose questions based on the video. Learners start arguing and discussing the video content. At this stage, learners who possess different ideologies are asked to substantiate their reasons and debate their stance. Teacher interaction at this stage will be minimal because learners will be leading the discussions. A teacher becomes a facilitator who only gives advice where it is due ModimolleSETI.

Lephalale provides technical ways of achieving learner-centeredness experience through content sharing between IWB and learners' tablets. Developing online assessment administered through IWB improves learner participation since monitoring could be done with ease. Reflecting learner results on the IWB afford teachers an opportunity to analyse and provide feedback immediately. From Lephalale's perspective, providing immediate results promotes competition amongst learners. Dealing with mathematical misconceptions picked from assessment serve as a corrective measure and a way of reteaching difficult concepts. Given learners' different intellectual abilities, projecting their results might make them feel discouraged especially those with lower scores. Lephalale holds a different view because this process could serve as an opportunity for learners to redeem themselves and share ideas on abstract concepts. As such, Lephalale advocates for online assessment which ensures active participation and instant feedback which has possibilities of expanding learners' knowledge.

Based on Capricorn's view, presenting Mathematics content through audio visuals promotes classroom participation and active learning. Learner attention becomes elevated when multimedia is used, especially if there are interactive activities. Learners dominate lessons when they engage in discussions and debates. From Capricorn's perspective, lesson discussions are effective when learners present their ideas as a group. The assumption is that, before they could present group outcomes, they would have had robust discussions and debates. Teacher dominance is overshadowed by high learner participation.

Modimolle echoed the same sentiments of using multimedia to promote learner-centeredness. The participant was adamant that the use of videos trigger learners' interest. Nowadays learners prefer learning with technology rather than traditional learning. Exposing learners to video contents entice their learning abilities. While playing a video during the lesson, Modimolle suggests that teachers should pause and ask questions which could encourage debates. The teacher facilitates the discussion by channelling learners in the right direction. As they discuss, Modimolle insists that teachers should assess, and group learners based on their reasoning so that they can substantiate their reasoning.

The cornerstone of a learner-centred teaching approach revolves around promotion of active, engaging and personalised learning experience. The fundamental aim of this approach is to move learners from remembering concepts to creative thinking capacity, constructive reasoning and effective way of engaging with others (Majola, 2020). The main idea here is for learners to make meaningful decisions out of any learning context and apply their mind when they are faced with real world challenges. The IWB offers teachers a supportive mechanism which promotes a collaborative and personalised learning experience (Wongwatkit, Panjaburee, Srisawasdi & Seprum, 2020). This is evident with Lephalale who sees learner-centred strategy as beneficial in most of Mathematics lessons. Lephalale believes in allowing learners to work on their own on the IWB to encourage active participation. By doing so, Lephalale believes learners will be more engaged in solving problems other than listening to the teacher. Teachers who are using IWB effectively and applying a learner-centeredness approach are believed to be persuading learners to achieve academically (Oussou, 2020).

Capricorn's response explains the idea of personalised learning experience since learners were asked to individually focus on the video and make notes on all important aspects. From Majola (2020), personalised learning is achieved through learner-centred approach and by ensuring that learners flourish in their interaction with their peers. Exposing learners to diagrams and videos on the IWB, allows learners to have different perspectives and eventually construct concrete knowledge out of their experiences. Modimolle's response shows similar trends since it suggests that once a learner-centred approach is used in an IWB enabled classroom, learners start to engage, argue and discuss the video content. Modimolle promotes learner engagement by allowing learners who possess different ideologies to substantiate their reason and debate their stance. In the same vein, Bourbour (2020) supports the principle of having high learner interaction and maintains that through the multimodal aspects such as diagrams and videos, learners become capacitated to think and debate logically other than relying on abstract concepts.

Learners learn beyond their schooling years, exposing them to a learner-centred environment serves as a social investment since in the future, they can participate in community development programmes (Majola, 2020). They learn to build the spirit of Ubuntu since they can share, guide and suggest strategies that can benefit the entire society. Such learners, Majola (2020) states that they can identify common challenges experienced by the society and come up with better ways of solving problems at hand. Learner-centred approach encourages learners to be independent thinkers and responsible learners who take charge of their decisions. Hence Capricorn speaks about learners presenting their views upon finishing debating their views.

Teachers have the responsibility to arouse their learning interests by guiding them (Chiu, Moorhouse, Chai & Ismailov, 2024). They must develop Mathematics activities on the IWB that will attract learners' interest and make learning to be fun. Learners' attitude towards learning will be positive since they will be learning in a relaxed and innovative manner. Majola (2020) supports the notion of assisting learners because maximum learning potential can be unlocked through a scaffolding mechanism. Based on Modimolle's response, a teacher promotes scaffolding if he or she becomes less dominant and takes the role of becoming a facilitator. On the other hand, Lephalale believes learner-centred classrooms allow teachers to keep track of learners who are slow and deal with their problems immediately. High engagement could be realised since learners become free to defend their opinions. By doing so, learners' needs would be catered for since teaching would not focus on learners' understanding pace but on how well they acquire knowledge (Bourbour, 2020).

Learner-centred classrooms motivate learners to become constructors of knowledge rather than being passive receivers of knowledge. From Erdener's (2021) perspective, learners who attend in IWB classrooms develop stronger learning habits which persuade them to learn continuously. Learners' understanding level becomes elevated when exposed to IWB activities which foster interaction and participation. Their concentration level becomes higher since they don't rely on a single media to learn. The movement of graphics keeps learners clued to the IWB and noting important aspects of the lesson (Erdener, 2021). Reaching to a level of fully engaging and having learner driven lessons require teachers who can "recognise and accommodate children's needs and interests" using technologies (Bourbour, 2020, p.15). Lephalale argues for teachers using the IWB to track learners' challenges and addressing them immediately.

The findings reveal the extent to which teachers in IWB classrooms used a learner-centred approach to achieve an active learner environment. Through high learner dominance during Mathematics lessons, learners were able to construct meaningful knowledge by interacting with their peers. They became exposed to various multimedia which triggered their learning interest. Teachers became facilitators and assisted them where they encountered challenges.

5.6 Theme 3: Constructivist-oriented practices in Mathematics classrooms with IWB

Constructivists argue for construction of knowledge by an individual learner through internalising and interacting with concepts (O'Connor, 2022). A constructivist philosophy claims for an active learning process which involves holistic human thinking process (Majola, 2020). Learning in a constructivist platform requires learners to construct their own meaning and use their knowledge to solve real time challenges. Therefore, teachers have the responsibility to mediate learning through artefacts which assist learners to conceptualise knowledge better. Teachers are required to change their role to be facilitators throughout the learner's learning process. In this research study, participants exhibited different practices which conform to the constructivist-oriented practices. The teaching practices within participants' lessons showed different ways in which the IWB was used to promote learner-driven learning. Most participants revealed how their practices relate to the attributes of the constructivist theory such as improving learner attention, expanding knowledge retention, and helping learners to move from known to unknown concepts. Majola (2020) applauds teachers who are using a constructivist approach because they ensure that learners become independent thinkers and generate knowledge on their own. These practices encourage creativity since learners are not channelled to think in a certain way.

Teachers must promote independence and invention of knowledge which is not reliant on a single source of information. Therefore, technology plays an important role in bringing better context and content for learning (Bourbour, 2020). Teachers can use IWB to motivate learning patterns and ways of comprehending knowledge. Throughout the learning process, teachers are supposed to guide and direct learners to achieve lesson outcomes. However, learning should not be reduced to achieving specific outcomes. Open minded learning processes should be encouraged, and teachers should continue unearthing learning potentials in every individual learner. Ifinedo and Rikala (2019) recommend teachers who apply a constructivist approach in their lesson because they find the adoption of technology easy. This is supported by Cadamuro et al. (2020) because they maintain the idea that "teachers with constructivist oriented pedagogical beliefs are significantly more likely to use IWB than transmission-oriented teachers" (p.39). There is no doubt that the constructivist way of teaching puts learner-centred learning at the forefront and requires teachers to use teaching and learning tools to enhance their lessons. The response below explains how the IWB was used as a teaching tool to improve learning in Mathematics classrooms.

5.6.1 Sub-Theme 1: Improve knowledge retention in Mathematics classrooms

Learning is a process which requires mental processing of information, filtering, and formulation of links between information notes. Learners have responsibilities to learn and use what they have learnt to solve real life problems. Solving challenges means using one's experience or thinking process to deal with issues at hand. Those who can't retain knowledge would find it difficult to execute simple instructions. The challenges facing teachers especially in Mathematics classrooms include ways in which learners should be taught to retain knowledge more and apply it when it is necessary. Hence, most learners find Mathematics content unnecessary and not useful for everyday life. Teaching strategies have been changed to address these challenges; however, some learners still find it difficult to retain knowledge as expected. Evidence can be drawn from grade 11 Mathematics classrooms where failure rate is rife. Educational teaching tools came in many forms to address poor classroom practices. However, some teaching tools, especially technological ones, continued to be used poorly and became worthless resources. Failure to integrate technological tools has rendered school budgets wasteful and some resources became white elephants.

Some researchers recommended the IWB as a teaching tool because it has a potential to improve learner performance and achievements (Shi, Zhang, Yang & Yang, 2021). Apart from IWB affordances, teachers have a responsibility of using the IWB to advance learners' performance. If the IWB is correctly integrated, there could be active and meaningful learning (Bourbour, 2020). With reference to how the IWB was used to improve knowledge retention during their mathematics lessons, participants shared different experiences. Responses below show how different strategies were used to ensure that learners retain knowledge better.

> Presenting lessons in a different mode makes learners remember other than relying on the teachers' voice. Exposure to various multimedia content helps them to conceptualize Mathematics concepts better. Having different people explaining the same concept helps with depth of knowledge (CapricornSCTI).

> By creating interactive activities that allow learners to be fully engaged makes them to remember Mathematics concepts. The IWB brings knowledge triggers in the form of pictures, sound multimedia and other embedded tools. Learners remember easily when they practically interact

with content. Recapping on the previous content becomes easier and this makes their prior knowledge to be stimulated and be ready to absorb new concepts (ModimolleSETI).

The use of videos and audios allow us to replay content for more than once. Lesson recordings are used to drill learners to conceptualize and instil knowledge which can be retrieved when it is needed. Drilling learners on Mathematics content through visuals from the IWB helps in the retention of knowledge. Through stimulating their thinking in the form of allocating points or marks on assessment software, it encourages active participation and helps in knowledge retention (MopaniSATI).

Showing them, the same content repeatedly makes them remember what they have learned in class. Even though a learner can remember without proper knowledge what the content is about, seeing something like what he/she has learned the previous day might activate something in the learner's memory. Structuring Mathematics questions in different ways and writing them on the board made me determine if learners can remember and understand the content matter (MusinaSBTI).

The response from Capricorn suggests different modes to help in presenting Mathematics content and instil knowledge which subsequently gets to be retained easily. Content is brought in different dimensions, promotes easier conceptualisation and broadens learners' scope. Mopani, Modimolle and Musina share the same sentiments on how the IWB is used for knowledge retention. Their responses include using the IWB to drill or teach Mathematics repeatedly. Modimolle regards multimedia as a knowledge trigger because it stimulates learners' mental processing. Moreover, Modimolle emphasises recapping of content for knowledge retention.

Mopani's emphasis is also on using multimedia repeatedly for knowledge retention. Focus is put on recorded lessons which are used repeatedly to drill learners. Based on Mopani's response, drilling learners helps with remembering concepts. An enticer in the form of marks is revealed to arouse their understanding. Musina related the same experience with others by citing how Mathematics content should be presented to learners frequently to assist with remembering. For Musina, learners who watch and listen to multimedia gain and retrieve knowledge better than those who rely on text. Formulating questions based on what learners have studied allows them to synthesise concepts better. For Musina, questioning helps to validate learners' understanding and verify if indeed knowledge can be retrieved when it is needed.

Knowledge retention requires an active mind which constantly retrieves or recalls actions from experiences or previous lessons (Moşteanu, 2021). Constructivists argue for learner-centred teaching which promotes active learning. Retention of knowledge is highly dependent on active participation in the classroom activities (Moşteanu, 2021). The affordances of the IWB becomes useful when it comes to creation of activities which promote active learning experience. Hence Capricorn believes in presenting Mathematics lessons through different modes to enable them to remember well. The IWB's interactive features encourage learners to communicate and debate ideas. During their debates, information is internalised and synthesised to create new meaningful knowledge.

Research by Shi et al. (2021) put pressure on the teachers to effectively use the IWB to promote cognition. The IWB has benefits over blackboard especially if teachers use correct strategies (Shi et al., 2019). The effectiveness of the IWB has become prevalent in classrooms where learning is individualised and self-paced. Learners in these learning spaces have shown evidence of retrieving knowledge better and performing well with assessments (Gonzales & Gonzales, 2021). Although many scholars publicised benefits of the IWB, responses from participants indicate practices which partly demonstrate creative ways of using the IWB to improve knowledge retention. Most participants clarified how multimedia was used to promote remembering, however, drilling of learners repeatedly has surfaced from their responses. Of course, repetition of Mathematics lessons could be done without the IWB, especially if multimedia is not used but the multimodality of the IWB gives teachers advantage to present lessons differently. Hence, Shi et al. (2021) caution users of the IWB to apply instructions which are appropriate for the learning context. Furthermore, Shi et al. (2021) suggest that the IWB-based instruction could be more effective if instructors can apply "an independent learning approach" other than collective drilling of content with the hope of addressing knowledge retention (p. 296).

In general, research is in favour of IWB-based instruction because it is known to enhance learners' cognition (Shi et al., 2020). Furthermore, Ritella and Sansone (2020) put forward physical human interaction as an important aspect towards learning through experience. The concept of learning through embodied cognition is suggested to be increasing knowledge retention in IWB enabled classrooms (Ritella & Sansone, 2020). Applying teaching methods which promote high interaction with the IWB, and learners themselves could strengthen the knowledge retention. Responses from participants do not show any practice which suggests the use of embodied cognition. Therefore, Ritella and Sansone (2020) recommend teachers to structure IWB-enabled activities to include embodied practices since it has a potential of promoting knowledge retention.

Contrary to Ritella and Sansone's (2020) idea of embodied practices, Hoa, Ngoc Huy and An (2022) prefer usage of IWB-enabled activities which include vocabulary lessons. Structured activities have a way of provoking learners to use their vocabulary to accelerate their active thinking. Hoa et al. (2022) recommend teachers to acquire knowledge of using vocabulary activities to promote knowledge retention. Both Modimolle and Musina showed evidence of having vocabulary activities by explaining how writing multimodality concepts on the IWB could encourage knowledge retention if those concepts are learned repeatedly. Although Capricorn and Mopani argue for different multimedia usage for knowledge retention, their responses never showed any evidence of vocabulary activity usage. It is of utmost importance for teachers to be flexible in their teaching approaches and apply strategies which will promote knowledge retention.

5.6.2 Sub-Theme 2: Move learners' understanding from known to unknown during Mathematics lessons

From a constructivist perspective, learning is mediated through teaching tools which aim to move learners to a higher cognitive level. Learners acquire knowledge at different rates. Moreover, there are mathematical tasks which learners cannot solve without teachers' assistance. Therefore, teachers are expected to scaffold learners through IWB to improve their comprehension level. Innovative teachers leverage the IWB's interactive affordances to uplift learners' thinking process. Evidence from participants' responses demonstrated various ways in which the IWB was used to move learners' understanding from known to unknown. Participants expressed their views on how best they used the IWB's applications and programmes to improve learners' knowledge.

> I start presenting Mathematics lesson with aspects from the previous lesson before I move to complex aspects. These lesson aspects are presented on the board using a hide and reveal strategy. Their prior knowledge is assessed to determine if they are ready to move to a new topic or concept. Presenting questions on the board and linking them with new concepts help in creating a synergy between what they know and what they are about to learn. Assessing their prior knowledge helps in teaching at the level which is appropriate to learners' understanding (MusinaSBTI).

> I start most of my lessons with knowledge gaps identified during marking. I present areas that learners mastered on the board and allow them to give their opinions about these concepts. After the discussion I present the ones that are challenging and request them to link them to what they have mastered. If they cannot link them, I provide hints that will lead them to answers.

> During discussions, I show them possible answers so that I channel them in the right direction. (VhembeSCTI)
>
> Different tools such as presentations are used to introduce unknown Mathematics concepts. Questions are then formulated based on the presentation. Learners are asked to discuss in groups while I am guiding them throughout. Prior knowledge is assessed through informal discussion to gauge their understanding and later introduce new Mathematics concepts. Learners are asked abstract questions to check knowledge gaps. Once gaps are identified, I start to teach at the right level (SekhukhuneSETI).

Participants acknowledged how opportunities brought by the IWB allowed them to capacitate learners with high order thinking. Responses from participants are in favour of IWB usage because of its attributes to bring interaction and improve communication. Musina puts emphasis on teaching strategy which includes a hide and reveal approach for knowledge verification. Questions are formulated based on previous content and learners' responses help in assessing their readiness level. A synergy is then created based on the known and unknown Mathematics concepts. Strategies are then set to move learners to the desired level.

Like Musina, Vhembe puts prior knowledge as the determinant of future concepts. However, Vhembe is of the view that accessing prior knowledge allows teachers to gauge if learners carry relevant knowledge that is needed to introduce a new topic. Vhembe's response provides clarity on how hints would assist learners to answer questions. Multiple answers were used to channel learners' thinking patterns. Although Vhembe clarified how content is presented from known to unknown, no programme or tool was revealed as a scaffolding mechanism.

Unlike Vhembe, Sekhukhune suggests that presentation tools assist in displaying content and facilitate discussion during Mathematics lessons. Throughout the discussions, Sekhukhune maintains that learners use prior knowledge to defend their stance. Once the new topic has been introduced, they are required to shift their mental thinking to accommodate new knowledge. Teachers' assistance could be what learners need to attain high order thinking. Even if learners could reach a thinking peak on their own, Sekhukhune believes in validating their opinion by asking difficult questions. This will confirm if indeed learning has taken place. Their reasoning will tell if teacher intervention is needed.

Participants' responses showed gaps in terms of knowledge of using the IWB to capacitate learners' understanding. Even if there was evidence of programmes or tools used to improve learners' thinking level, participants could not innovatively use the IWB to scaffold learners' thinking process. Of course, the IWB might present opportunities for teachers to mediate learning better. However, teachers' knowledge of using IWB as a scaffolding tool is very significant. Without such knowledge, learners would continue to struggle in the presence of advanced technological tools. Hence, Samsonova (2019) believes that teachers should creatively produce activities that would escalate learners' understanding to a higher level through IWBs.

The use of graphics presents an opportunity for teachers to improve learner cognition because they can distinguish various shapes and trends (Aldalalah, 2021). As they visualise Mathematics concepts, different perspectives are explored, and their thinking process becomes elevated. So, helping learners with graphics builds learners' confidence and creates possibilities for independence. Stimulating learners' interest by building relationships encourages them to explore and build more knowledge further. Linking of concepts allows them to relate and have a better understanding of the subject matter. When concepts are linked, Aldalalah (2021) suggests a scaffolding mechanism placed between concepts so as they could assist in moving learners throughout the levels. Examples of these scaffolding mechanisms could be graphics and multimedia because they stimulate hearing and sight senses (Aldalalah, 2021). A practical use of the scaffolding mechanism is demonstrated by Sekhukhune's usage of presentations. The assumption here is that, in Sekhukhune's presentation, there should be diagrams and graphics which could assist learners.

Another scaffolding mechanism would be the teacher's ability to mediate learning through IWB in a diverse classroom. In fact, Shoraevna, Eleupanovna, Tashkenbaevna, Zulkarnayeva, Anatolevna and Nurlanbekovna (2021) believe that teachers should develop creative interactive exercises which should encourage learners to think critically. According to Shoraevna et al. (2021), these exercises could develop learners' thinking skills and become creative in every lesson. Although classroom activities are given preference for good interaction and knowledge acquisition, Shoraevna et al. (2021) caution teachers to not relegate teaching strategies because they are as important as these exercises. Usage of graphics coupled with application of good teaching strategy could assist in the development of learners' thinking process.

Research shows that teachers should use creative scaffolding mechanisms which trigger the human sensory system to comprehend abstract concepts (Hoa et al., 2022). Teachers' intervention could permit learners to comprehend and apply Mathematics concepts with ease. Without teachers' assistance, it would be difficult for learners to relate abstract Mathematics concepts with their real world.

5.6.3 Sub-Theme 3: Improve learner attention for active learning during Mathematics lessons

There is no doubt that the IWB possesses attributes which contribute immensely to the classroom teaching practices (Gonzales & Gonzales, 2021). Moreover, the IWB showed evidence of capturing learner attention through its ability to project content in various colours or shapes and produce sound and gestures which draw one's hearing or sight (Gonzales & Gonzales, 2021). The unused IWB features would remain ordinary for as long as teachers do not harness them to enhance their classroom practices. Therefore, failure to use technological tools which have possibilities of improving teaching and learning would not make the IWB enabled classroom to differ from a classroom with chalkboard.

With reference to participants' practices of using the IWB to improve learner attention, the responses showed evidence of learner engagement and active class participation which translated to learners being attentive during Mathematics lessons. Various IWB programmes and tools were cited as enablers of capturing learners' attention. Participants demonstrated how the IWB was used to improve learner attention in the following manner:

> Learners like fiddling, so sometimes as a teacher, I allow them to use the IWB to either write or draw Mathematics figures. With that, their attention becomes elevated since they start participating throughout the lesson. As they fiddle with the IWB, at times, they write equations and compute them such that the IWB will draw a graph according to the equation. In that way, they even predict the outcomes of their equation before the IWB can draw the graph. Learner's interest is aroused by content that is zoomed and manipulated to enhance their understanding (MakhadoSDQ).
>
> Learners are helping teachers with IWB navigation in most instances. Since learners' master technology more than teachers, they become very interested and ready to help teachers locate IWB's tools. Learners are compelled to follow teachers because they are ready to assist where teachers are getting stuck. Most of them are learning various skills through other teachers and assistant technicians who are doing internships (MusinaSBQ).
>
> Learners are eager to touch and play with the IWB during lessons. Since they are given rules not to touch the IWB in the absence of teachers, during mathematics lessons they all become excited since they know that they will start fiddling with the IWB. However, others have tendencies of

> hiding icons and applications on the IWB. They take pride in frustrating teachers when they want to access applications such as Geogebra. They would request the teacher to tell them what he or she is looking for on the IWB. This ensures that they pay fully attention since they are always ready to help and understand teachers' intentions (VhembeSCQ).
>
> Through interacting with the IWB physically, learners explore and have a feel of navigating through Mathematics graphs. Manipulating functions through Geogebra and gallery which may be used to access mathematical pictures and multimedia content (WaterbergSDQ).

Given the flexibility of teachers to allow learners to fiddle with the IWB, chances are learners were free to participate during the lesson. The emphasis from participants was on giving learners a chance to explore and practise Mathematics concepts on the IWB. Makhado's view shows how learners are trusted to fiddle with the board without fear of deleting or uninstalling programmes. Makhado claims that physical computation of equations and graphs on the IWB encourages learners to be attentive and follow instructions. Musina uttered the same sentiments by providing reasons why learners' attention gets captured during IWB usage. For Musina, learners are more techno-survey than teachers therefore during lessons; learners have the upper hand in terms of locating and navigating IWB tools. Musina claims that while learners are assisting teachers with technological skills, they are bound to be attentive because they can only guide if they understand what is supposed to be done. Therefore, by virtue of learners wanting to help, their assistance comes with listening skills. Over and above learners' assistance, Musina mentioned how technicians help with technical problems. What prevails from this helping narrative is that learners see themselves as having chances of being future technicians because of their computer skills. As such, they always see every Mathematics lesson as opportunities to showcase their excellence.

It is interesting to see how Vhembe explains how learner attention is captured during lessons. Vhembe appreciates the collaboration between learners and teachers towards achieving a common goal. Learners in Vhembe's case have upper hand in terms of technological skills. However, teachers as disciplinarians have set rules to govern how IWB should be used especially in their absence. While teachers are emphasising on rules, learners strengthen teacher dependence on IWB usage by hiding icons from teachers. Vhembe believes learners take pride in frustrating teachers in terms of failing to access programmes and content. Though this practice can be seen as unwelcoming, Vhembe believes their technical skills enable them to focus on what teachers are doing with an intention to help where necessary. They would not help if they were not paying attention, so helping teachers to locate

Mathematics content could improve their attention and knowledge about what programme could be used for which lessons.

Waterberg agrees with the rest of the participants about letting learners to physically interact with the IWB to promote active learning. Learners become attentive when they become hands on during lessons. For Waterberg, manipulating graphs on the IWB allow learners to pay attention to instructions to execute plans or actions. Responses by participants showed how teachers used Geogebra and multimedia to capture learner attention. Few participants appreciated how Geogebra ignites the interaction between learners and the IWB. What needs to be investigated further is whether learners' physical interaction with the IWB improves performance in Mathematics since most participants are in favour of IWB improving learner attention.

Karthigasu and Mohamad (2020) consider teaching as a process which requires innovation and creativity. A boring Mathematics lesson would result in learners losing interest in learning and end up skipping classes. Karthigasu and Mohamad (2020) regard IWB as a tool that could improve participation because IWB enabled classrooms showed a positive influence on learner attention. A non-dynamic teacher would not keep learner's concentration span longer. Suwarma and Apriyani (2022) challenge teachers to create tasks through IWB which requires high concentration, communication and collaboration. Teachers are advised to have high learner dominant lessons rather than lessons where learners spend time writing notes or listening passively in class (Suwarma & Apriyani, 2022). Participants' response of allowing learners to fiddle with the board and generating graphs from equations serves as a good example of high learner dominant lessons. Over and above learners participating in class, Suwarma and Apriyani (2022) recommend lessons which incorporate activities that require high order skills for problem solving. Such lessons expand the learner's thinking capacity and boost self-confidence.

From Alsolami and Saaty's (2020) perspective, using IWB to teach enables flexible learning because information can be mediated through different means. Learners in IWB enabled classrooms concentrate on tasks other than wanting to memorise concepts. Musina and Vhembe recommend learners for their willingness to help teachers when they are struggling. Through helping teachers, learners also benefit from mastering Mathematics content. Understanding is of paramount importance during lessons; learners become motivated to learn something new when they do not struggle with content (Alsolami & Saaty, 2020). The use of multimedia stimulates learners' thinking and builds capacity to view concepts in different perspectives. This is supported by Mihai (2020) who argues that IWB enabled classrooms have tendencies of stimulating learners' interest, feel motivated and elevate their attention.

Nowadays, learners prefer technological devices for learning, they find reading textbooks and novels boring. When learners are exposed to multimedia, they become attentive and cooperative. However, out of excitement, learners could become noisy and playful. This requires teachers to manage the classroom well without compromising the interactive and relaxed atmosphere which could improve learner attention. That is why Erdener (2021) insists on recognising teacher's capability to mediate content through IWB rather than giving recognition of IWB only towards bringing learner attention. In other words, IWB alone cannot improve learner attention without the teacher's intervention.

Vhembe and Waterberg cited Geogebra as one of programs which stimulate learners' interest and encourage participation in Mathematics classrooms. Drawing from participants' experience, the use of this program captures learners' attention due to its nature of having visuals and sound. Erdener (2021) recommends such programs because they stretch learners' attention level and participation. The use of multimedia coupled with good teaching strategies allows high interaction with IWB and has proven to improve learner attention especially where learners are dominating during lessons.

5.7 Theme 4: The affordances of IWB augment interactivity in the Mathematics classroom.

The last theme presents views explaining how classroom interaction during Mathematics lessons is amplified through IWB's affordances. The IWB by nature has interactive features which prompt users through commands. These features are isolated from activities designed on the IWB to promote interaction among users. Over and above interactive activities, the access to Mathematics interactive online tools and multimedia could serve as another means to encourage interaction among learners, teachers and content. Interaction serves as the fundamental process for learning and without it, learning would not exist (Lockman & Tamis-LeMonda, 2021). Learners are social beings; they learn through others and through interacting with the environment around them. This is in line with social constructivists who argue that a child constructs knowledge through interacting with artefacts and the outside world (Lockman & Tamis-LeMonda, 2021). Therefore, for any technological device that would facilitate interaction could enhance teaching and learning during Mathematics lessons.

Yu (2020) advocates for the IWB's interactivity because it can promote active learning and interactions in class. Based on Yu (2020), teachers should take advantage of IWB affordances and use them to improve learner-learner, learner-content and learner-teacher interactions. The interactions are known to benefit learners with high order thinking, logical reasoning and collaborative skills (Yu, 2020). To promote high participatory learning, teachers should nurture students to become free and active agents within the learning space. Learners should from time to time be in contact with their fellow learners for discussion purposes, interact with Mathematics content and teachers for guidance.

Participants' responses showed the importance of using IWB as an interactive tool to promote communication and collaboration. Part of the findings includes explanations on how Covid-19 regulations have disadvantaged learners and teachers to have robust interactions. However, participants revealed alternative strategies which allowed learners and teachers to continue interacting. Participants provided evidence of classroom interaction through using the IWB as an interactive and collaborative tool.

5.7.1 Sub-Theme 1: IWB as an interactive tool in Mathematics lessons

This sub-theme focuses on how Mathematics teachers used the IWB as an interactive tool to improve teaching and learning. Given the affordances of the IWB, it is important to note that utilisation of IWB does not automatically mean it could be used as an interactive tool. There are instances where IWB is used as a chalkboard especially if users have limited skills (Mokoena et al., 2020). In such occurrences, learners are robbed of an opportunity to have a physical interaction with the board or amongst themselves particularly when they have personal devices linked to the IWB. However, in instances where the IWB's interactivity is correctly used, there have been cases of high interaction between learner-learner, learner-content and learner-teacher. So, participants' responses spoke volume about how they used the interactivity of the IWB to improve their Mathematics lessons. Various strategies were used to promote interaction between learners and teachers.

> The IWB allows teachers to present Mathematics content on the board and write comments on the content without erasing. While the teacher is writing comments, learners are encouraged to discuss and share ideas. The IWB allows a teacher to present rich Mathematics content at a short space of time while leading learners to participate holistically. The teacher ensures that discussions are answering questions that are related to Mathematics content by leading them during the discussions (MopaniSATI).

> By giving learners questions that will demand them to research and enquire more during the lesson, the IWB has helped me to present Mathematics diagrams or puzzles for learners to acquire necessary skills and knowledge to solve. Through these puzzles, learners are forced to think deep and work in groups to come up with solutions. Members of the groups are encouraged to work collaboratively with others towards solving Mathematics problems. The teacher only

> comes in where there are challenges that are difficult for learners to comprehend. Hinds and clues are given during the discussion process for directing learners to the right direction of the lesson (VhembeSCTI).
>
> Encouraging debates in the classroom helps learners to fully participate in class. Allowing learners to explain their findings individually to the entire class help with learner centred. Learners who could not understand the teacher's explanation will also benefit from their peers' explanations. Learners will be free to ask their peers questions since it will be easier to engage with their peers than with the teacher (WaterbergSDTI).

The response from Mopani shows evidence of basic interactive features of the IWB to encourage classroom participation. Although Mopani talks about presenting Mathematics content on the board and writing comments, there is no explicit explanation on how this content is presented using interactive features. Even though Mopani promoted discussions in class, there were no examples which suggest how the IWB triggered those discussions. Furthermore, Mopani bragged about discussions helping with learner participation, but no proof was provided which suggests how IWB was used to improve learner interaction.

Waterberg gave a similar explanation with Mopani, explaining how debates and collaborative activities were encouraged as interactive strategies to promote active participation. Learners' confidence and morale were boasted as they individually explained their findings to the entire class. Waterberg claims learners who found the lesson challenging benefited from the discussions. Even though Waterberg mentioned all interactive strategies, there was still no evidence of IWB usage which suggests that a specific programme or software was used to achieve that interaction. Where learners are discussing or debating, there will be interaction but what is not clear is how the IWB was used as an interactive tool for active learning.

Vhembe brought a different experience by mentioning Mathematics diagrams, exercises and puzzles which require learners to research and acquire more knowledge to solve them. Learners were encouraged to work in groups and fully interact amongst each other. Evidence of learner-learner and learner-content interactions were apparent in Vhembe's explanation. During discussions, Vhembe insisted that a scaffolding mechanism should be used to uplift learners to the required level in terms of content comprehension. Learners were guided to remain relevant and productive in achieving lesson objectives.

The IWB's potential of providing teachers with interactive platforms is entirely dependent on how it is used for learning. Teachers who take advantage of the IWB's affordances to mediate learning have possibilities of exposing learners to enormous educational platforms. The IWB could afford learners' access to rich Mathematics content, promote active interaction in class and move content between devices. Luo et al. (2023) are in support of IWB usage because of its interactive nature and ability to transform learning to be authentic and practical. Moreover, the IWB has a potential of improving learner-teacher interaction provided teachers apply correct pedagogical approaches (Divya, 2023). What surfaced from participants is the ability of teachers to encourage sharing of ideas and working together to solve mathematical problems. Although Mopani and Vhembe do not categorically explain how they used IWB as an interactive tool for learning, their explanations show evidence of active interaction between learners and teachers. They both suggest that group discussions and collaborative activities emerged during lessons.

Based on Luo et al. (2023), IWB's interactivity has a potential of improving learner concentration level and they become highly motivated to learn through multimedia platforms. When IWB are used interactively, learners find learning fun and become free to engage during discussions. It is for this reason that Gonzales and Gonzales (2021) recommend the IWB because of its ability to produce and project interactive activities which go beyond normal traditional chalkboards. With reference to participants' views, Mopani suggests that IWB has the potential of presenting rich content for learners. On the other hand, Vhembe sees the IWB as a technological tool which could display diagrams and puzzles which could trigger interaction among learners and teachers. Although most participants are in favour of using IWB as an interactive tool, their practices have evidence of using the IWB like chalkboard. Their IWB usage lacks innovation and the interactivity of the IWB is not harnessed to the maximum.

Failure to take advantage of IWB's interactivity could result in poor presentation and boring lessons. Such lessons would have passive learning experience with less interaction among learners. Gonzales and Gonzales (2021) advise teachers to use content with sound and video effects that grasp their attention and allow them to have physical interaction with content. A Mathematics classroom which could afford learners to enlarge diagrams, replay and manipulate graphs by inserting functions would be deemed interactive. By virtue of learners fiddling with Mathematics content using the IWB's interactive tools such as pens, clickers and finger detectors; teachers still have the responsibility to integrate these tools with their lessons. The learner-learner, learner-content and learner-teacher interaction would not exist without proper integration of Mathematics content knowledge with IWB. The IWB will remain less effective until its affordances are properly exploited to improve teaching and learning.

5.7.2 Sub-Theme 2: IWB as a collaborative tool in Mathematics lessons

The nature of the IWB allows physical and virtual interaction with users and creates opportunities for learners to participate better during Mathematics lesson. The IWB's interactive features afford teachers opportunities to structure activities which would require learners to work together to achieve a common goal. The research-based activities which demand active and hands-on learning could keep learners engaged and allow them to be accommodative of suggestions from other learners. Erdener (2021) is in favour of the IWB's interactive nature since it can provide instant feedback which could facilitate debates amongst learners. The learner interaction could improve their concentration span because of high engagement and active participation during lesson discussions. The idea of using IWB as a collaborative tool centre on teachers' way of teaching.

Ifinedo and Rikala (2019) argue for development of a collaborative culture in a teaching environment. Teacher's experience should be that of a collaborator before technology aspects can be brought into the picture. The interaction between teachers, learners and technology builds a reputable environment where learners find it easy to learn and communicate information (Ifinedo & Rikala, 2019). Central to learner interaction is how they are stimulated through technological artefacts which could improve their knowledge construction, retention and reasoning capacity. It is therefore important for teachers to use technology as knowledge triggers through open interactive platforms that foster collaboration (Ifinedo & Rikala, 2019). Research has proven that correct implementation of collaborative tools could improve learners' thinking process and build mutual relations with time (Boutefara & Mahdaoui, 2020).

Based on teacher experience, participants showed different experiences of how the IWB was used as a collaborative tool in Mathematics classrooms. The IWB has various applications which could foster collaboration amongst teachers and learners. However, it is entirely dependent on teachers to take advantage of these applications to improve learner-learner and learner-teacher interaction. Where there is learner interaction, collaboration is likely to happen. There can be no collaboration if there is no interaction. Participants showed different strategies used to encourage collaboration through IWB. When asked how they used the IWB as a collaborative tool to enhance their teaching in their Mathematics classrooms, they responded as follows:

> Through online tools such as the Siyavula platform, learners can attempt Mathematics questions from this platform and later work as a team. After their discussion, the teacher will guide them on how best they could have answered the questions and add more on to what the teacher feels is important to the lesson. Misconceptions will be clarified during the discussion by posing

questions that are more challenging. The teacher will clarify missing aspects of the topic which could not be picked up during the discussion. Expanded opportunity questions will also trigger debates since there will be follow up questions that will require learners' reasoning (CapricornSCTI).

The IWB encourages a learner-centred teaching approach since concepts that are shown on the board require learners to discuss and reflect on their understanding. Learning is not passive in IWB enabled class since they are not only listening to the teacher, but they also become part of knowledge presenters. In the middle of the lesson, a teacher can switch between IWB modes and that attracts learners' attention. Once their attention is captured, I encourage them to discuss their understanding in groups. When they are done debating, I push them to report to the entire class in the form of writing and voice presentations (ModimolleSETI).

Learners are given IWB pens to present their ideas on the board. This is done randomly to encourage maximum participation. Less participating learners are given more responsibilities so that they can be used to answering questions. During Covid-19 restrictions, they were not allowed to sit in groups, so small group discussions become impossible. Learners only discussed as a class and when they do not agree on a concept, they prefer teacher's intervention. At times, I encourage participation through online platforms such as WhatsApp, and I reward those who participate more with non-educational videos that they watch during their spare time (MusinaSBTI).

To promote collaboration, grade 11 learners from various classes can share and discuss their Mathematics notes through sharing applications available on the IWB. The IWB has functionality to allow teachers to allocate learners roles in their collaborative activities and ensure that learners share with the teacher videos that are educational through the internet. Teachers can record themselves and be played on the board (WaterbergSDTI).

Evidence from participants showed attempts of using basic and advanced collaborative strategies to teach Mathematics concepts. Participants' responses showed how they used their skills to integrate IWB into their Mathematics classroom to promote collaboration. Based on Modimolle and Musina's responses, they both relied on the IWB's basic features to encourage collaboration. These participants argued that the IWB's mode of presenting content enabled learners to work as a team. Teachers' pedagogical approach ensured a collaborative atmosphere in both cases (Modimolle and Musina). Both participants allowed learners to physically interact with the IWB to encourage active participation. The assumption here was that learners would start collaborating especially when they are tasked to work in pairs or groups during problem solving.

Musina acknowledged the challenges brought by Covid-19 and embraced usage of IWB online tools to foster active participation and collaboration. However, Musina has not mentioned any IWB's online applications which could be innovatively used to encourage collaboration. WhatsApp was cited as one of the online applications used for communication and collaboration. Musina has demonstrated the inability to use collaborative online applications such as blogs and wikis.

Contrary to Modimolle and Musina, Capricorn and Waterberg used online resources for collaboration. Even though more examples of these collaborative features were not mentioned, they both suggested that content was shared through online platforms. During content sharing, participants showed that collaboration was encouraged through online platforms. Participants were in favour of the IWB's audio-visual features because they helped to improve learners' listening skills which are the cornerstone of communication. Good listeners are good communicators; collaboration becomes easier with learners who are good listeners.

From Chiu et al.'s perspective, appropriate use of technology could trigger learner's interest to learn and participate in problem solving (2024). Erdener (2021) encourages IWB usage since it has a potential in improving innovation, learner engagement and teamwork. When collaborative features of the IWB are correctly used, learners independently engage with subject content without teacher's intervention. Learners construct their own knowledge by actively engaging on collaborative platforms which foster communication and active learning. Tran (2021) sees IWB as having various interactive tools which allow numerous learners to participate and collaborate with ease. Through shared content, learners could work together in the projects which require multiple responsibilities. Tran (2021) is in favour of pedagogical practices that support the use of Web 2.0 tools (sheets, google docs, etc.) and collaborative tools (MS Teams, Skype, Wikis, and blogs). When learners are exposed to these tools, collaboration would not be limited to classroom interactions.

Alharbi and Khalil (2022) argue that those with innovative skills to use IWB as a collaborative tool could do so through synchronous and asynchronous mode. The asynchronous mode would enable users to have access to offline materials while synchronous mode would enable online interaction among learners and teachers (Alharbi & Khalil, 2022). Even though both modes have their own merits, researchers argue for a blended approach because with technologies, learners could be reached any time (Alharbi & Khalil, 2022). With a blended approach, learners could physically collaborate and expand their interaction through online platforms. Utilising IWB as a collaborative tool within blended teaching disciplines could bring inclusivity and their social presence would be valued since constant interaction would be eminent in and outside the classroom.

Drawing from Boutefara and Mahdaoui's experience, encouraging class interactions through technologies only could lessen social presence (2020). Such experience could reduce social physical interaction which could end up affecting their relations. Learners experiencing such practices could suffer from isolation, lack of social bonding and affection. The natural togetherness experienced in an asynchronous platform should be natural beyond classroom experience (Boutefara & Mahdaoui, 2020). Otherwise, learners would suffer from lack of physical presence which could lessen their chances of interaction and collaboration. Therefore, teachers should be cautious in their attempt to use the IWB as a collaborative tool because mutual engagement could be compromised if learners are not limited to one mode of collaboration.

In relation to learner engagement and collaboration in IWB classrooms, participants demonstrated how the IWB promoted group discussions and active participation during Mathematics lessons. In other instances, learners were encouraged to work in teams when they discuss or solve problems. Physical interaction with the IWB helped to bring better perceptions during discussions. Teacher's intervention through stimulating non active learners helped to achieve active collaboration. The overall responses from participants demonstrated limited usage of IWB since most collaborative features were used to access and exchange content. The IWB's collaborative features could not be used to trigger debates outside the classroom environment. Participants relied on learners' physical presence in class to use the IWB for collaborative purposes. Participants could not use online platforms to reach learners and encourage collaboration while they are outside the classroom.

5.8 Conclusion

This section has extensively presented, interpreted and analysed findings from participants' responses. Analysis of individual online interview and questionnaire responses resulted in generating four themes and sub-themes which are aligned to the research questions. The first theme discussed factors influencing IWB usage and participants showed how classroom context and content dictates technology usage. Among other dominating factors were teachers' attitudes, knowledge and skills of using IWB. Teaching strategies for IWB enabled classrooms was presented as the second theme. For this theme, participants recommended teaching strategies which intend to accommodate various learning experiences. Emphasis was put on matching the teaching strategies with technological teaching tools. The third theme focused on the constructivist-oriented practices in IWB classrooms. Participants' responses from this theme demonstrated how IWB was used to improve knowledge retention and move learners' understanding from the known to unknown. The last theme discussed how affordances of IWB amplified interactivity in the classroom and participants displayed different experiences around IWB usage. Usage of IWB as an interactive tool to promote communication and collaboration was dominating throughout participants' responses. Even though participants used the IWB differently, their teaching approach had collaborative practices.

B. Quantitative data analysis, interpretation, and presentation

This section has presented, analysed and interpreted data qualitatively looking at the general experience of using IWB versus the experience of using IWB to teach Mathematics in grade 11. Considering a descriptive analysis of theme 1 in the previous section which focuses on the factors affecting IWB usage in Mathematics, this section chose sub-theme 4 to test if there are correlations with qualitative analysis. Finding from qualitative analysis of theme 1, sub-theme 4 showed no relation between the number of years of teaching with technology and teacher experience.

The section used Chi Square to test the relationship between two variables and determine whether one variable had an influence on the other. Although the study used Chi Square to analyse and interpret data, it is important to note that using fewer participants could produce weak statistical results. And this could result in making invalid conclusions.

Table 6 presents observed values in relation to the two variables (general experience of using IWB and the experience of using IWB to teach Mathematics in grade 11)**.** With reference to understanding how IWB's teaching experience relates to Technological Pedagogical Content Knowledge, the study used interactive tools which foster collaboration, communication and active participation to investigate their practices. To further give clarity with IWB teaching experience, the study looked at the experience of using the IWB in general (the assumption is that teachers might have used the IWB to teach other subjects at any grade) and experience of using the IWB in Mathematics grade 11 classroom. Based on the observed values, a table of expected (Table 7) was generated.

5.9 Calculation of Chi-square (X^2)

The study calculated a Chi-Quare by first presenting observed values first. Secondly, a Null hypothesis and Alternative hypotheses were formulated. A Significance level (α) was chosen to be 0,05 and a table of Expected Values was generated. Calculation of X^2 value together with the degrees of freedom followed. The X^2 calculated value was then checked if it is greater or less than the X^2 Tabular value. The decision to reject or accept the null hypothesis is based on the comparison of the two values (X^2 calculated value and X^2 Tabular value).

Table 6 Observed Values

General experience of using IWB. Versus Technological Pedagogical Content Knowledge of using IWB to teach Mathematics in grade 11	**Technical Knowledge to use IWB to teach.**	**Digital Pedagogical knowledge to teach through IWB**	**Knowledge of using Multimedia to teach.**	**Knowledge of using web-based content through IWB**	**Using interactive tools to teach**	**Using tools that foster active participation.**	**Using tools that foster communication.**	**Using tools that foster collaboration.**	**Total**
General experience of using IWB.	8	8	9	6	7	7	8	8	61
Experience of using IWB to teach Mathematics in grade 11.	6	7	6	5	5	8	7	8	57
Total	14	15	15	11	12	15	15	16	118

Null hypothesis: General experience of using IWB and experience of using IWB to teach Mathematics in grade 11 are independent.

Alternative hypothesis: General experience of using IWB and experience of using IWB to teach Mathematics in grade 11 are not independent.

Significance level (α) = 0,05

Table 7 Expected Values

Technological Pedagogical Content Knowledge of using IWB to teach.	Technical Knowledge to use IWB to teach.	Digital Pedagogical knowledge to teach through IWB	Knowledge of using Multimedia to teach.	Knowledge of using web-based content through IWB	Using interactive tools to teach	Using tools that foster active participation.	Using tools that foster communication.	Using tools that foster collaboration.
General experience of using IWB.	7,2	7,8	7,8	5,7	6.2	7.8	7,8	8,3
Experience of using IWB to teach Mathematics in grade 11.	6,8	7,2	7,2	5,3	5,8	7,2	7,2	7,7

Table 8 Calculation of X^2

Observed value (O)	Expected value (E)	(O-E)	$(O-E)^2$	$\frac{(O-E)^2}{E}$
8	7,2	0,8	0,64	0,09
8	7,8	0,2	0,04	0,01
9	7,8	1,2	1,44	0,18
6	5,7	0,3	0,09	0,02
7	6,2	0,8	0,64	0,10
7	7,8	-0,8	0,64	0,08
8	7,8	0,2	0,04	0,01
8	8,3	-0,3	0,09	0,01
6	6,8	-0,8	0,64	0,09
7	7,2	-0,2	0,04	0,01
6	7,2	-1,2	1,44	0,20
5	5,3	-0,3	0,09	0,02
5	5,8	-0,8	0,64	0,11
8	7,2	0,8	0,64	0,09
7	7,2	-0,2	0,04	0,01
8	7,7	0,3	0,09	0,01
Total				1,03

Calculation of X^2 is 1,03

Calculation of Degrees of freedom = (Columns – 1) *(Rows -1)

= (8-1) * (2-1) = (7) *(1)

= 7

Table 9 X^2 Tabular value

	P										
DF	0.995	0.975	0.2	0.1	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	.0004	.00016	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.55	10.828
2	0.01	0.0506	3.219	4.605	5.991	7.378	7.824	9.21	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.86	16.924	18.467
5	0.412	0.831	7.289	9.236	11.07	12.833	13.388	15.086	16.75	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.69	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.18	11.03	13.362	15.507	17.535	18.168	20.09	21.955	24.352	26.124
9	1.735	2.7	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.92	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.3	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.79
18	6.265	8.231	22.76	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.9	27.204	30.144	32.852	33.687	36.191	38.582	41.61	43.82
20	7.434	9.591	25.038	28.412	31.41	34.17	35.02	37.566	39.997	43.072	45.315

Significant Level (α) = 0,05

X^2 Tabular value = 14,07

X^2 Calculated = 1,03

Thus, X^2 Calculated < X^2 Tabular value.

Therefore, we accept the Null hypothesis and reject the alternative hypothesis.

That means the number of years of using the IWB and the experience of using IWB to teach Mathematics in grade 11 are independent. There is no relation between the number of years of using the IWB and their experience using IWB to teach Mathematics in grade 11. The skills and knowledge which can be referred to as Technological Pedagogical Content knowledge towards teaching with technology is independent from the general experience of using the technology. This suggests that one cannot conclude that a teacher with high number of using ICTs will possess adequate Technological Pedagogical

Content knowledge. Similarly, a teacher with less experience of using ICTs to teach cannot be assumed to be having less Technological Pedagogical Content knowledge.

Drawing from the qualitative analysis, participants acknowledged the use of ICTs and regarded utilisation of these resources as a step in the right direction towards integrating curriculum with ICTs. However, what was also emphasised is that utilising ICTs without correct technological and pedagogical content knowledge will result in mismatching pedagogical approaches. An example can be drawn from Giyane's emphasis on merging teaching strategies with ICTs during Mathematics lesson presentation. Those with a high number of experiences of teaching with ICTs without possessing correct technological pedagogical content knowledge would find technology integration difficult. What is important is how technology should be integrated into the school curriculum without looking into the teacher's ICT teaching experience. This can be backed by the experience of two participants such as Giyani and Modimolle who have vast differences in their IWB experience. This is evident enough to suggest that the number of years of teaching with ICTs is independent from application of technological pedagogical content knowledge. Similarly, the quantitative findings also suggest that the number of years of teaching using ICT does not guarantee possession of correct technological pedagogical content knowledge.

5.10 Conclusion

There are correlations between the quantitative and qualitative analysis outcomes. The value of IWBs and their affordances to enable teachers to be better mediators of content has brought high penetration of these technologies in the classroom. Availability of IWBs in Gauteng township schools has necessitated scholars to investigate if indeed these technologies bring value to the school curriculum. Scholars zoomed into many aspects which would have an effect in maximising IWB integration in the classroom especially where learner performance is poor. As emphasised earlier, availing IWBs would not be a solution to poor integration, without considering other factors which could be classified as internal and external (Ardıç, 2021). Some of these factors include the ones discussed during qualitative and quantitative analysis which were based on the research questions. The findings from the qualitative and quantitative analysis presented in the previous section assisted to develop a thematic discussion. The thematic discussions which integrate the entire research findings are thoroughly presented in the next chapter.

Chapter 6 Thematic Discussions and Findings Synthesis

6.1 Introduction

This chapter builds on the themes and sub-themes presented in the previous chapter generated from the interviews and questionnaires. The thematic analysis has assisted in finding an in-depth understanding of the multimodal affordances of Interactive Whiteboards and establishing how teachers' preparedness and attitudes affect the integration of IWBs as pedagogical tools in teaching of grade 11 Mathematics content. This chapter discusses the main findings in relation to the reviewed literature and theoretical framework of the study. As mentioned earlier in chapter 3, the findings influenced the development of a new modified Teacher Preparedness and Usage of IWB conceptual model drawn from the UTAUT model. The UTAUT model has been significantly used to determine the technology adoption and gauge technology usage based on user intentions and behaviour towards technology usage (Venkatesh et al., 2003).

To show a correlation between the research findings and the conceptual model which put emphasis on the importance of having correct pedagogical technological content knowledge and experience of teaching with the ICT device towards innovative integration, a summary table is provided below. Table 10 clarifies the relationship between the research findings and literature on how teachers' experiences have implications on their daily teaching practices.

Table 10 The research findings and literature relationship

Teachers' preparedness and attitudes	**Related Construct in the UTAUT**	**Implication**	**Remarks**
• Technical and general ICT skills are key influencers of IWB usage. • Those with TPACK knowledge and skills would integrate IWB into teaching. • Pedagogies, technology and subject content should be aligned to a teaching strategy. • ICT resources are productive tools for teaching and learning. • Teachers who are knowledgeable about technology and its benefits would excel in using the technology. • IWB makes learning more meaningful. • IWB is useful and helpful. • IWB provides opportunities for learning.	Performance Expectancy	Teachers will use the IWB if they find it benefiting, useful and productive. Those with knowledge and skills of IWB will excel in their teaching.	A technology worth using is determined by how teachers value its performance and abilities.
• Teaching with IWB saves time. • IWB is an easy and faster tool to present content with. • IWB helps to present content simpler, accurate and significant. • IWB serves as a scaffolder during teaching. • IWB's interactive feature promotes communication and collaboration.	Effort Expectancy	Teachers use ICTs that are simple to navigate. Teachers are using ICTs that are user friendly and saves their teaching time.	Any technology that is easy is likely to be used by teachers.
• Schools require teachers to be better users of IWB throughout their teaching experience. • GDE expect teachers to excel in their teaching. • Gaining adequate experience of using the technological tool than to accumulate general teaching experience.	Social Expectations	Teachers are aware of expectations from their schools and the GDE to deliver quality teaching through IWB. Teachers are expected to teach differently and harness the affordances of IWB to	External influence and expectations push teachers to utilise IWB. Society's expectation has high impact on the degree of IWB utilisation.

• Teachers are expected to use diverse teaching strategies when they use IWB. • IWB should be used to produce practical exercises which assist learners to internalise concepts and formulate meaningful knowledge.		produce better learning outcomes.	
• Formal teacher trainings were conducted through GDE's teacher development programme. • School technicians assist teachers with technical challenges. • Teachers receive technical assistance and navigation of the IWB from learners who intern benefit in the process. • Teachers use IWB as a scaffolding tool to improve learner's comprehension level. • Physical interaction with the IWB and collaborative features of the IWB.	Facilitating Conditions	IWB trainings, technical assistance and support on content navigation assist teachers to use IWB.	The IWB's interactive nature and other features that promote communication and collaboration benefit users. The support through formal and informal trainings enables teachers to acquire necessary skills for IWB usage.

6.2 Factors influencing IWB usage in teaching Mathematics content

Technology users are known to be influenced by internal and external factors which drives their usage and desire to use technology. Participants also mentioned their preference when it comes to factors which determine IWB usage. However, what came out common amongst participants was the sub-themes discussed in chapter 5. The degree of these factors differed from one person to the other. Some value other factors more than the others while others seemed to believe that they all influence usage equally. This showed how diverse participants were in terms of these factors. Zooming into the participants' responses; more information was given based on their understanding and value of which factors would best have influence on IWB usage. Participants who value skills and knowledge over their attitude spoke strongly about how one cannot utilise technology without skills, and they disregarded attitudes because according to them, skills supersede attitudes. Scholars such as Huang, Qi and Xie (2022) support the notion that teachers must be knowledgeable within their working space since they are seen as agents of change. The degree to which technology will influence teaching and learning will be highly dependent on teachers (Huang et al., 2022). Hence Burke et al. (2022) put teachers' skills and experience of using technology at the forefront because they influence the adoption of technology. It is assumed that those with skills and knowledge would find it easy to use IWB.

Research has shown that lack of skills hinders technology usage (Burke et al., 2022) and teacher training is recommended to those who require these skills. To support this claim, participants showed the importance of acquiring skills to better fiddle with the IWB. Those who shy away from fiddling with technology, Bardakci and Ünver (2020) suggest that they tend to develop negative perceptions about technology. Users become reluctant to use technology and later they abandon technology. Drawing from participants' responses, limited and unstructured skills were acquired over some time throughout teaching with the technology. Although Sekhukhune and Mopani emphasise that their skills got sharpened the more, they interacted with IWB, there was evidence of limited innovation in their ICT integration. Hence there was a need for development around the IWB which was attained through structured and unstructured trainings. Even though few seen themselves as possessing IWB integration knowledge, but findings showed that their skills were superficial. There was no evidence of innovation, and their teaching was confined to the tools in their exposure. Therefore, working with IWB would encourage development especially where there is collaboration and constant communication. Skills and knowledge of IWB alone would not guarantee frequent usage and this was evident in this report because other participants voiced factors which seemed very important for usage.

6.2.1 knowledge and skills of using IWB to teach Mathematics content

Considering participants' responses in chapter 5 about the knowledge required to improve technology usage, most teachers were adamant that technological knowledge is significant. Although knowledge of using technology is often narrowed to technical knowledge, scholars suggest that TPACK knowledge contributes highly on technology usage (Huang et al., 2022). Combining teaching strategies and technology, content knowledge is regarded as a key strategy towards ICT integration. Participants' responses suggest the need to acquire skills with which integration would yield positive lesson outcomes and without which mismatching of pedagogies would be realised. Zooming into Giyane and Modimolle's responses, those with skills and knowledge would use technologies and teaching strategies that are properly aligned. This is not surprising because Raygan and Moradkhani (2020) also emphasise the importance of mastering the interaction between TPACK knowledge components. However, they do not nullify the idea of developing and having a positive attitude towards technology usage. More weight is still put on TPACK knowledge since positive attitude alone would be impractical to use it as the only influencer of technology usage. It is not surprising that Ardıç (2021) value the importance of acquiring knowledge and skills through interacting with multiple technologies to improve digital teaching strategies. Zooming into what emerged from this research, most of the participants showed the importance of having technological knowledge and skills to teach, however, integrating sets of knowledge to produce TPACK knowledge was attempted by few. In fact, all of them showed no signs of being innovatively integrate IWB into their Mathematics lessons.

Emphasis from participants' responses was on using the IWB to teach effectively and produce opportunistic learning environment. Some of the participants did not raise TPACK knowledge in their responses, their understanding of technology matching teaching method showed understanding of TPACK set on knowledge (Technological knowledge, Pedagogical knowledge and Content knowledge). Lephalale emphasis of Mathematics content having to match with teaching strategies showed signs of valuing TPACK knowledge. However, most teachers could not fully harness the affordances of IWB to systematically incorporate TPACK knowledge. Ammade, Mahmud, Jabu and Tahmir (2020) stress the significance of the three sets of knowledge to be having effective and fruitful teaching outcomes. Mismatching of these sets of knowledge would bring pedagogical practices which yield poor learning outcomes. For Ammade et al. (2020), such teachers would require thorough training of the application of TPACK. This is because teachers are influencers of learning. How they mediate learning is highly dependable on the knowledge and skills around subject content and the technology accompanying the content (Absari, Priyanto & Muslikhin, 2020). Technology is evolving thus introducing IWB in Gauteng schools was a good initiative especially that these technologies processes attributes which are relevant for today's teaching strategies. The preparedness of teachers would include TPACK knowledge and correct application in a classroom setting among other things.

6.2.2 Teacher awareness of the IWB as a productive, time saver and easy tool to teach Mathematics classrooms

Over and above knowledge and skills contributing to IWB usage, participants' awareness emerged strongly, and participants voiced their opinions on IWB usage in Mathematics classroom. Throughout the discussion with participants, they all acknowledged to be having their own assumptions about education technologies in general. And their preconceived ideas around the IWB usage were not exceptional since the introduction of IWB in schools. Participants appeared to have liked the IWB because of its abilities to present lessons, save lessons for future use, display content easier and faster. What came out common was its ability to store and retrieve information with ease. Musina and Makhado speak highly about how content is presented from various sources. On the other hand, Vhembe and Waterberg showed how Mathematics content can be manipulated for better presentation of concepts. Hence, there are examples which include how reflection of figures is achieved through features of the IWB. Without any doubt, participants' responses showed positive insights and regarded IWB as the most favourable technology suitable for teaching of Mathematics. Among other views of the IWB, it was its ability to safe time, presenting information accurately and helping teachers to be productive during lessons, just to mention a few.

Boonmoh, Jumpakate and Karpklon (2021) share same sentiments with participants in this study that technology is seen as a vital tool for knowledge creation and exchange. However, how teachers see a technological tool would possibly affect how the tool is going to be used. For Abel, Tondeur and Sang (2022), teacher perception is the determinant of technology usage. Those who regard technology as a hindrance would be reluctant to use it or use it poorly. The relevance of technology in education is dependable on how it is viewed, and which would also affect how it is used. Those who do not integrate or use technology effectively because of poor perception would require a mental shift since perceptions are mentally bound. Human mind is influenced by social and cultural setting which an individual finds himself or herself in (Abel et al., 2022). Those with high exposure to technology and support would use technology to their advantage. Their frequent access would put them at an advantage over others. Hence advanced users of IWB such as Waterberg claims that because of IWB, teaching and syllabus completion becomes faster. For most participants, IWB was seen as a scaffolding teaching tool especially in cases where mediation of Mathematics content came from unknown to known. The attributes of IWB coupled with positive awareness of IWB creates opportunities for teachers to be creative and innovative. This in turn promotes active learner participation and coherent learning (Karthigesu & Mohamad, 2020). With learners taking charge of their learning space, their presence is felt through high performance. Such environment is symbolized by extremely motivated and engaged classrooms (Lai, 2019). Although participants showed high regard for IWB, this could not guarantee full preparedness because awareness about the productivity of a devices does not guarantee full usage.

6.2.3 Teachers' attitude towards teaching Mathematics content through IWB

One's attitude is mainly influenced by internal characters such as belief systems, values, perceptions, understanding and experience of a particular concept or situation. So, attitude is not derived from outside, it is an internal factor that is built to gauge and respond to external aspects. Wijnen, Walma van der Molen and Voogt (2021) regard attitude as being three dimensional. Firstly, it comprises of behavioural perceptions which attributes one's beliefs and feelings. Secondly, they are the social norms perceptions and these points to the social tolerance towards the behaviour. Lastly, it is the behaviour control perception which relates to the ability to control oneself in terms of how one would act towards behaviour. When examining these perceptions, one would realise that participants responded using these three-dimensional attitudes. Some of the participants' reasoning was based on their beliefs and feelings about how IWB enhances their teaching of Mathematics in IWB enabled classrooms. What came out strongly from participants' initial beliefs was that IWB would waste their teaching time because of its complexity and technical requirements. However, with time, they have learnt to apply the social norm perception which emphasises the tolerance to adopt and adapt the IWB as an effective and efficient teaching tool. Similarly, through experience, participants have learnt to have ways of using the IWB to encourage communication, collaboration and interaction. This is evident enough to explain how participants' behavioural control through internalising and using the attributes of the IWB worked to their advantage.

Another example of attitude being influenced by perceptions can be drawn from Musina who initially perceived IWB as a time-wasting tool. From the previous chapter, I have already argued that Musina's age coupled with few years of interacting with the IWB makes it reasonable to have this perception. Another interesting example is that of a young participant, Modimolle, who perceives the IWB as a plug and play tool. However, through experience gathered from trainings and interactions with subject content on the IWB, Modimolle started understanding complexities and advantages of using IWB to mediate Mathematics content. Of course, users' confidence to technology usage is directly related to the experience and development initiatives one is exposed to (Huynh & Nguyen, 2021).

Teaching is a practice that is influenced by social and emotional aspects. Teachers carry along these emotions, perceptions, and attitudes in their teaching practice especially if a new technology is introduced. Therefore, teachers' attitude towards technologies such as IWB cannot be taken for granted. For Ardıç (2021), attitude is one of the determinant influencers of technology usage. Developing a positive attitude towards technology is the most important stance towards technology adoption and adaption (Regan et al., 2019). Such experiences are portrayed by Mopani who embraced IWB and used it to bring classroom interaction and present Mathematics content practically. Surely Mopani's attitude after becoming a frequent IWB user and possessing adequate skills has exceeded the expectations that Wijnen et al. (2021) put forward as teachers' role of stimulating learners through digital technologies. A teacher's negative attitude towards technology would integrate technology with subject content poorly. In fact, technology in such situations may be regarded as an optional tool which could also be irrelevant to the lesson. According to Lai (2019), teachers' perception and attitude towards technology dictate how a technology could be used. The consequences of poor integration and poor usage of IWB lie with those who perceive technology negatively and not wanting to bother themselves with learning the affordances of those technologies. Teachers' attitude cannot be left behind because based on Huynh and Nguyen (2021), resistance to technology usage is based on teachers' attitudes towards the technology concerned. Even though attributes of attitude such as beliefs, feelings, perceptions, values and feelings were brought forth to be major contributors of technology usage, teacher's experience of using technology has been noted to have similar influence on IWB usage. Experience on its own is known to be a contributor of one's attitude.

6.2.4 Teacher's experience of using IWB to teach Mathematics content

Experience is gathered through exposure and access to technology. Exposure alone would not guarantee experience; one must interact with technology to become frequent user and acquire experience thereof. However, experience does not equate to effective usage of technology. Data gathered from participants showed different experiences of technology usage and it was interesting to see contradictory results based on the IWB usage versus teacher experience. The quantitative analysis in chapter 5 showed no correlation between the number of years of using the IWB and the Technological Pedagogical Content knowledge of using the IWB to teach. Scholars like Gonzales and Gonzales (2021) assume that the frequency of technology usage affects one's experience, and such a user would adopt technology easily. Although experience to technology is suggested to be advantageous in technology usage, evidence from this research study showed that those with less experience were able to teach effectively with IWB. Introduction of the Paperless Classroom solution in the FET band was to give teachers access to technology and use modern pedagogies to improve learner performance. This resulted in grade 11 and 12 teachers benefitting more than most teachers. The assumption was that, with time, they would develop adequate skills which would improve their teaching since teacher training could not cover all technical and pedagogical aspects. Participants such as Lephalale and Giyani would be expected to use their vast experience to develop digital pedagogies and teach well with IWB. Scholars such as Bonafini and Lee (2021) support users with technology experience because without experience, teachers would encounter challenges with digital pedagogies.

Responses of experienced users of technology claimed to be possessing adequate knowledge of using IWB. Drawing from the literature review, three sets of knowledge of the TPACK model puts each knowledge through its discipline. Therefore, some participants could be referring to Technological Content knowledge (TCK) as their experience of using the IWB, whereas others see Technological

Pedagogical Knowledge (TPK) as a technology teaching experience. Zooming into Vembe and Musina's responses, one would notice that their experience has to do with TCK and TPK. Initially, they were not fluent users of the IWB but with time, they gained knowledge of usage. For such users, Anderson and Putman (2020) suggest that they are sensitive and cautious users who believe in steady improvement. For Anderson and Putman (2020), their confidence is built on numerous activities which could later be equated to experience. On the other hand, Giyani's claim of using the IWB's features and learning materials to improve lesson presentation creates an impression of wanting to apply correct digital pedagogies during teaching. According to Anderson and Putman (2020), such users could use their experience to boost their confidence and willingness to use technology.

Participants have shown the impact of acquiring experience through formal and informal trainings, self-taught, trial and error and self-paced interactions. Implementation of these strategies equips teachers with relevant knowledge which will contribute towards their experience of technology usage. In cases where there is no formal training, acquiring knowledge is driven by self-will. This is mainly because teachers are expected to master teaching with technology within a short space of time (Van der Spoel, Noroozi, Schuurink & van Ginkel, 2020). For those who are lucky to receive training, Anderson and Putman (2020) emphasise that the drill-and-practice strategy would expand their teacher experience.

6.2.5 Conclusion

This theme has zoomed into internal and external factors which influence how IWB are used for teaching and learning. Participants have strongly put skills and knowledge as best influencers of IWB usage. They argued that those with knowledge of using IWB to teach would probably integrate them innovatively into their lessons. It was further argued that those who possess knowledge about IWB would perceive them as modern teaching tools with affordances that can improve interaction, communication and collaboration. Those who view IWB as educational tools to teach Mathematics would probably adopt the tool with ease. As previously highlighted, Regan et al. (2019) argue that attitude is a key factor towards adopting IWB usage. Participants also acknowledged that they gain experience as they interact with IWB to teach. Access to IWB was declared as a key component towards usage and participants felt they gain experience when they frequently teach with these tools. Although participants' experience was interchangeably referred to as having Technological Content knowledge (TCK) and Technological Pedagogical Knowledge (TPK), possession of TPACK knowledge is seen to be most critical and important influencer of IWB usage. Those who possess this knowledge could be innovative users of IWB.

6.3 Teaching strategies for Mathematics classrooms with IWB

Technology has brought a need for new ways of teaching that is built on the capabilities of technology and mediation of content through technology. As technology is evolving and penetrating classrooms, teaching strategies would not remain stagnant since technology serves as a tool for teaching and learning. Technologies such as IWB allow teachers to shift from a boring teacher centeredness approach to a more practical, enjoyable, and engaging teaching practice which motivates and encourage learner participation (Hussein, Ahmed, Shawkat & Kamil, 2022). Although these modern teaching approaches do not come automatically, they require adequate integration of technologies into teaching. The previous sections have already emphasised attitudes, TPACK knowledge and experience of using technology to teach, just to mention a few. Moreover, with common challenges ranging from poor technical skills, poor ICT integration skills and lack of access to IWB, applying teaching strategies for IWB enabled classrooms would require more than ordinary adoption of IWB.

6.3.1 Digital pedagogies for Mathematics classrooms

In this technology era, most common and buzzing words are digital tools, digital literacy and digital citizenship. Gradually, societies are transforming themselves through technological means to become part of the digital world. In schools where digital technologies are highly adopted, transformation of teaching approaches would be eminent, and teachers' practices would suit the digital space. As earlier emphasised in chapter 5, modern technological tools brought into Mathematics classroom require contemporary teaching approaches that promote active learning. Therefore, digital technologies brought to the classroom must be accompanied with digital pedagogies. Modern technologies have forced teachers to plan and prepare Mathematics lessons before they could be delivered. Features of these technologies require teachers who could navigate Mathematics content without losing track of learner's attention and participation. It is not surprising to see participants supporting the use of multimedia in Mathematics classroom because of its audio-visual affordances. Through rich content, which is easily accessible from the IWB, it enables teachers to diversify their teaching strategies. Modimolle and Waterberg's notion of teaching through videos clearly shows the edge to adopt and adapt digital strategies that suit digital content. Both participants recommend the idea of pausing the video while teaching so that important ideas can be emphasised or raise questions where necessary. This approach is crucial according to Samsonova (2019) because teaching becomes learner-centred especially where subject content is mediated through modern technologies.

Zooming into other digital tools such as online diagrams and interactive tools that teachers used to improve their teaching of Mathematics concepts, this has necessitated participants not to rely on their traditional teaching and listening approach but to apply a digital strategy that promotes learner engagement and presentation of content in different forms. Anderson (2020) praises those who effectively apply correct pedagogies within the curriculum sphere because such teachers can recognise learners' prior knowledge and contextualising their teaching towards learners' experience. Although there are few teachers who applied digital pedagogies, evidence from this research showed that teachers develop good teaching strategies throughout their teaching experience. Frequent usage of IWB coupled with internal efforts such as attitude and willingness of using the IWB to enhance teaching has come out to be appropriate for the adoption of modern digital pedagogies. When teachers apply correct digital pedagogical strategies, they tend to promote learning approaches that promote independency, active collaboration and self-paced learning (Anderson, 2020). Such pedagogies could be regarded as being productive and effective because they are learner oriented and builds on the notion that learning should be internalised using most of the sensory features. Through digital tools, learners could apply their senses (touch, feel, hear and watch) on multimedia content which may promote different perspective and comprehension of knowledge. With correct application of digital pedagogies, teachers could promote classroom practices that present broad based learning which affords learners opportunities and self-development techniques in their learning journey (Toktarova and Semenova, 2020). Although this research advocates for teachers to have necessary ICT skills and correct pedagogies for teaching in digital classroom, a systematic development is needed to capacitate these teachers to eventually become innovators in their Mathematics classrooms. The previous chapter has shown that during the initial stage of using the IWB, teachers struggled a lot with integration of Mathematics content and technology. Hence Yu (2020) believes in technological development for teachers especially now that technology is evolving rapidly and that contextualising technology in the classroom requires teachers who are willing to match the digital classroom demands.

The use of online tools (videos and presentations) requires teachers to apply correct digital teaching strategies. Although participants could not explain how they have applied digital teaching strategies, their argument was that through IWB Mathematics content was presented simpler and easy. According to them, playing videos and pausing in the middle of the presentation showed application of strong digital pedagogies. However, this was not enough since there was no evidence of active participation and innovation. Although some participants used ordinary IWB tools to enhance their teaching, they appreciated these tools since they acknowledged that free hand drawings and non-digital content would delay teaching time. Preparation and structuring of Mathematics content before teaching emerged strongly as one of the strategies that promote usage of digital content in the classroom. If planning if not thoroughly done, digital tools could destruct learning since there would not be good strategies on how these tools should benefit learners.

6.3.2 Accommodating diverse learning experience in Mathematics classrooms

The complexities of the learning processes could be addressed through digital tools that can accommodate diverse learning experiences. Regardless of learners' economic, social and behavioural position, their learning styles would always differ according to their preferential way of knowledge comprehension. Of course, subject content is internalised individually and differently, so the ability to create a classroom context where knowledge is highly constructed and acquired with minimal barriers would be ideal for innovative teachers. Teachers' classroom practices should cater learning dynamics where learning preferences are well catered for. Those who advocate for IWB such as Bourbour (2020), believe in its multimodality which can offer opportunities and learning experiences that promote inclusivity, diversity and cohesiveness. The collaborative features of the IWB promote constant interactions amongst learners and their perceptions are always interrogated through open discussions. Participants have elaborated how videos and graphical representation of Mathematics content afforded learners opportunities to comprehend concepts that could be abstract to teach or learn. Hence Mopani advocated the use of Geogebra as one of the Mathematics software which could produce best graphical representation of Mathematics function into graphs.

Participants showed the importance of recorded lessons to accommodate different learning experiences. With these lessons, it is argued that learners can repeat them to further analyse and comprehend the topics concerned. Self-directed learning can be maintained by allowing learners to learn at their own pace and stimulating their interest through multimedia and online tools (Ichimura, Noda, Nakano & Suzuki, 2020). Learners could be supported through scaffolding mechanisms which promote flexible and self-driven learning experience (Ichimura et al., 2020). The IWB has online tools such as Massive Open Online Courses (MOOCS) which has multiple learning opportunities which could be used to cater for different learning experiences. Even though MOOCS offer variety of online content for learning, participants lacked knowledge and experience of using these platforms. This proved lack of enthusiasm to explore platforms outside their usual teaching platforms. There is no doubt that online tools could accommodate diverse learning and promote self-paced learning because content can be structured based on learners' cognitive level. What most participants lacked was the ability to use these online tools to accommodate different learning experience.

On the other hand, what seemed dominate was how teachers used the IWB to cater for learners' diversity and differential learning preference especially in multicultural classrooms. Participants acknowledged the multimodality of the IWB and felt it is important to use features of the board effectively to ensure inclusivity during lessons. Various sources and platforms from the IWB were suggested to be capable of building high interest for learning and satisfying learners' individual needs. According to Page, Charteris, Anderson and Boyle (2021), when learners' needs are not met, they tend to suffer emotionally, and their academic achievements are also compromised. Teachers are therefore encouraged to incorporate strategies and technological tools which improve learner engagement and participation. Without putting pressure on learners with low academic scores, teachers are encouraged to build such learner's confidence considering their abilities and learning strategies. This could be achieved through modelling and mediating multimedia content in a multilevel teaching approach.

The IWB presents accurate graphical presentation of subject content in many fields. Participants in this study have attempted to use visuals to enhance their teaching but there is no evidence on the pedagogical integration of these visuals to accommodate learners' individual learning preference, experience and capabilities. Meaning, the use of visual could not present expanded opportunities for learners who are struggling with Mathematics concepts. And as such, learners with special learning needs would continue to be excluded and suffer socially and academically (Page et al., 2021). On the other hand, Price and Slee (2021) insist that technology classrooms should not focus on learners with special learning needs only; there are those who are gifted, some have learning barriers and others have disabilities. The IWB should be used to cater for all learners beyond their physical and mental abilities. Therefore, teachers should unearth learners' potentials by stimulating their preferable learning experiences through these technologies.

6.3.3 Promotion of learner-centeredness in Mathematics classrooms

Teachers are implementers of curriculum, their responsibility among other things is to ensure that content is mediated according to curriculum's objective. However, this does not mean that learners are not active participants within the curriculum equation. The reason teachers adopt and apply different teaching styles is because they recognise learners as contributors to the learning space. A good teaching approach should be applied in an appropriate learning environment to achieve a vibrant learning and teaching experience. The ideal approach would be where learners are fully engaged and scholars call this approach a learner-centred teaching approach (Du Plessis, 2020). The focus in this approach is mainly on learners' participation and engagement during lessons. Central to learner-centred approach is the constructivist learning theory which put emphasis on learning as a process that is internalised and embedded within interaction with others. What counts as wisdom for teachers is the ability to acknowledge learner contribution and interaction during lessons because learning is internalised and reflected through active participation such as debates and discussions. Abdullah, Soh, Mokhtar, Hamzah, Ashari, Ali and Rahman (2020) advocate for active learning and discourage teacher dominant lessons where learners spent time observing and listening to a teacher without engaging learners to participate both orally and physically. In passive learning environment, learners do not become accountable for their actions since they do not take charge of their own space and learning process.

Drawing from participants' views of creating a learner-centred approach, evidence shows that the IWB features challenged teachers to be creative and apply contemporary approaches which brought high learner attention and participation. Lephalale's technical idea of connecting learner devices with the IWB has made them answer and compare their results with others. This could spark debates because some learners could question their differences and defend their stance. The minute learners start debating, their thinking process improves, and they acquire what Abdullah et al. (2020) call it High Order Thinking Skills (HOTS). Such learners become logical in their reasoning because they can critically analyse and apply their synthetic thinking accordingly. With the IWB providing opportunities to Mathematics classes, Capricorn's view of taking advantage of the IWB's audio visual features serves as an advantage to create active learning environment. It is argued in the literature review, the IWB creates many opportunities for learning. The IWB's audio and visual features have proven to improve learner concentration in various classrooms (Karthigesu & Mohamad, 2020). And this is not surprising that Capricorn favours the IWB over other teaching tools. What serves as an important aspect in IWB classroom in Capricorn's lesson is the ability to mediate Mathematics content that can stimulate learners' thinking and cause debates while a teacher is facilitating the discussions.

Scholars have argued that learner-centred approach can only be achieved when learners are fully inspired and motivated to learn (Li, Ding & Zhang, 2024). Those who present learners with opportunities to express their thinking and create a learning environment that is conducive for learning would find it easy to have active learning participants. Not only will learners become active participants, but they would be smart or sharp thinkers. Participants have so far showed range of IWB tools which could be used to promote communication, collaboration and interaction. As correctly put by Abdullah et al.

(2020), the IWB could be used to scaffold learning, provided correct pedagogy is used during teaching process. The call here is the application of a teaching approach that provides opportunities for learners using modern technologies. Fostering a learner-centred approach would shy away from reproduction of ideas but focus on instilling high order thinking, open mindedness and creativity.

6.3.4 Conclusion

Participants in this theme have shown various ways of using the IWB tools to achieve lesson objectives. Not only have they achieved their learning objectives, but they have demonstrated abilities to use features of the IWB to promote a learner-centred teaching approach during their Mathematics lessons. There have been clear descriptions on how the IWB was used to promote active participation, scaffold learners using different IWB programmes and improve their thinking. Hence, Modimolle sees a teacher as facilitator of learning other than master of all. Although participants argued that a range of IWB's features could assist in improving their teaching, their responses could not reflect usage of online tools. Participants denied learners opportunities to explore these tools and learn beyond classroom walls. Teachers' innovation was limited to resources known by them without going beyond their usual experience. Therefore, there is a need for teachers to be capacitated to adopt and apply digital online tools to promote learner-centred approach which could improve a self-driven and interactive learning.

6.4 Constructivist-oriented practices in Mathematics classrooms with IWB

Technology has advanced drastically, and this has influenced the implementation of school curriculum. A teaching strategy that was dominant and favoured in the early 1980s cannot be relevant in this era. These teaching strategies have been put under scrutiny given the dynamic classroom contexts. With, technology becoming inseparable from the school curriculum, schools are faced with a challenge of adopting these technologies to improve their teaching practices. The existence of digital and online tools has necessitated application of teaching strategies that merges the attributes of these tools. Availability of these tools in our classrooms has made traditional teaching approaches to be redundant and irrelevant. Although there are pockets of Gauteng township secondary schools where traditional teaching approaches are practised, evidence shows that learners in those schools are denied opportunities to meaningful and collaborative learning (Cadamuroet al., 2020).

Literature has shown how attributes of the IWB can promote communication, collaboration and interaction in the classroom. The responsibility lies with teachers to use the IWB to promote active participation and innovation in their lessons. Teachers who are correctly using collaborative features of the IWB would have highly engaged classrooms. Although, teachers are of the view that using audio-visual stimulates learners' sense, a good teaching strategy would make content knowledge more meaningful and practical (Tanrısevdi, 2021). Teachers' abilities of applying a constructivist teaching approach in a technology enhanced classroom would be dependent on the innovative qualities he or she processes.

6.4.1 Improve knowledge retention in Mathematics classrooms

Responses from participants have provided evidence that the multimodal features of the IWB enable learners to retain knowledge better. Learners can comprehend Mathematics concepts easier when they are presented in various forms (visuals, audio, etc). Participants were in favour of the touch and drag feature of the IWB because it allows learners to physically interact and manipulate diagrams. Participants were adamant that learners will retain knowledge easily if they physically interact with subject concepts on the IWB. Over and above the physical interaction, participants showed the importance of creating interactive activities which immensely engage learners into Mathematics lessons. Although some hinted other strategies that support a behaviourist approach such as repetition of concepts, their approach aimed at scaffolding learners to acquire adequate knowledge. As correctly mentioned by Moşteanu (2021), knowledge retention can only exist where there is active thinking.

Participants demonstrated the need to use multimedia to stimulate learners' thinking and apply strategies that elevate knowledge retention process. The use of visuals triggers learners' mental association and thinking processes (Cadamuro et al., 2020). Learners validate their mental models through comparing the actual models that are seen on the screen. Similarly, their mental processing becomes systematic due to continuous reflection of their mental schemes. While knowledge is being comprehended and processed during active learning, retrieval of such knowledge is purely depended on remembering (Gloy, Weyhe, Nerenz, Kaluschke, Uslar, Zachmann & Weyhe, 2022). To improve learners' mental cognition, teachers are advised to use technology that brings virtual reality and expose them to the outside world. Participants in this study demonstrated how videos can used as a form of exposing learners to multimedia content which could be easily understood by learners because of its practical feature.

Part of the IWB's benefits was its ability to structure Mathematics concepts systematically and logically. Participants used the IWB to structure their Mathematics lessons in a manner that concepts would be interlinked according to how they relate. Based on Musina's reasoning, structuring Mathematics concepts systematically helps learners to build new knowledge from their prior knowledge. Linking what is known to what is not known could only be achieved when learners' thinking is stimulated by concepts that require them to be active thinkers. It is for this reason that Mopani suggested the software which could be used to drill learners' thinking and improve their understanding around concepts that are challenging and difficult to comprehend. When such concepts are well understood, retaining them would be much easier because they form part of the acquired knowledge. In accordance with Alsarayreh (2021), this is because modern technology exceeds the expectation of learners having to memorise concepts without understanding. In modern technology classrooms, learners are said to be motivated in their learning due to the interactivity of technology and this in turn makes them to retain knowledge better (Alsarayreh, 2021). Where there is passive learning, learners would find it difficult to remember concepts because they are not actively involved.

Advocacies of project-based learning believe that through series of practical and endless activities, learners can retrieve knowledge better because they are required to solve current problems based on the previous knowledge (Vesikivi, Lakkala, Holvikivi & Muukkonen, 2020). In project-based learning, learners require minimal scaffolding because learning is self-paced, and knowledge is gradually build based on their experience. Although participants in this study did not mention project-based learning, they are of the view that the interactive nature of the IWB helped learners to practically interact with content. Hence Modimolle advocates for the use of embedded digital tools on the IWB to assist learners with physical interaction of Mathematics content. Vesikivi et al. (2020) believe that learners' knowledge retention improves when there are reflective sessions of the existing knowledge. Therefore, recapping on the previous Mathematics lessons as one of the strategies suggested by Modimolle would allow learners to reflect on what they have learned before. As learners reflect, analyse and contrast information, knowledge acquisition and retention become improved.

It is interesting to realise how participants used technology to help learners retain knowledge other than mere remembering of concepts without understanding. Pressure can be put on teachers to expose learners to various IWB platforms which could increase their depth knowledge of Mathematics concepts. Access to videos afforded learners an opportunity to view different presenters explaining similar concepts differently. Although, there was evidence of multimedia content usage, it is recommended that teaching strategies should match classroom tools. Learners will benefit from these learning setting since learning will be more meaningful, active and realistic because explanations are practical and learners' thinking becomes stimulated to retain knowledge efficiently and effectively.

6.4.2 Moving learners' knowledge from known to unknown during Mathematics lessons

Unlike the traditional teaching approach, technology enhanced teaching approach is providing enormous opportunities for digital learning through digital means. Although content ought to be mediated regardless of its format during learning, the digital content is not confined to the classrooms (Wong, 2021). The affordances of digital content through technologies such as IWB, has made learners to have access to content anytime. Learners are afforded an opportunity to interrogate their stereotypes through interacting with Mathematics multimedia content which could not be understood when presented orally. Learners bring along social experience during learning process; what is known to them as scientific knowledge might be a myth. Based on Wong (2021), the cultural experience that learners bring to school, helps towards construction of new knowledge. Learners' cultural knowledge and social background affect their internalisation of new concepts. As they internalise concepts, their experience which is shaped by the environment would affect how this new knowledge is conceived. Therefore, teachers have a responsibility of shaping learners' prior knowledge into concrete knowledge.

Responses from participants showed the importance of assessing prior knowledge before introducing new knowledge. An emphasis was put on understanding learners' prior knowledge and shaping it into a scientific knowledge. For participants, understanding learners' prior knowledge helps teachers to start teaching at the learners' level of understanding. Teachers would also prepare scaffolding mechanisms in cases where learners cannot comprehend abstract knowledge. Although most of the teachers could not explain how features of the IWB helped them move learners from known to unknown concepts, but few attempted to use digital teaching strategies that could enable learners to acquire new knowledge. Teachers who have mastered the art of synchronising technology and teaching strategies to meet new teaching goals are regarded as the most prepared teachers (Henriksen, Creely & Henderson, 2020). Through teachers' innovations strategies, learners' cognition level could be challenged and forced to adapt to new scientific approaches.

Teachers design lessons for a purpose and these lessons are built to achieve certain goals. Whenever such goals are not met, teachers would apply different teaching strategies to remedy the situation. Given technological tools such IWB and Mathematics concepts to teach, teachers would need to apply a pedagogical innovative skill to achieve lesson outcomes (Henriksen, Creely & Henderson, 2020). Over and above their creative teaching, participants have treasured linking and interconnection of concepts which ought to be built from simple to complex level. Scaffolding mechanism is applied in between linked concepts. Aldalalah (2021) suggests that most learners would achieve lesson outcomes. And in a digital teaching space, these scaffolding mechanisms could range from multimedia aids to practical interaction of Mathematics content through simulations and artificial intelligence (Aldalalah, 2021). The ability of an enhanced digital learning platform to bring real-world experience to learners allows them to conceptualise concepts in a concrete and systematic approach. As they move from known to unknown concepts, their confidence improves because their reasoning is not based on assumptions but scientific experience.

To continue bridging the gap between the known and unknown concepts, participants appreciated the value of assessment as it made teachers establish barriers of learning. Of course, these assessments were administered through technologies which enabled teachers to dwell more on Mathematics concepts which were less understood. A practical example can be drawn from Musina and Vhembe's responses of presenting concepts and questions on the IWB to evaluate learners' prior knowledge. Musina further showed the importance of connecting known and unknown concepts especially after identifying knowledge gaps from learners. Wong (2021) put emphasis on the importance of using technology to sequentially build lessons based on their complexity. Equally important, assessment also helps teachers to structure Mathematics lessons according to their understanding. Hence, most participants cited assessment of prior knowledge as a significant process of linking known with unknown knowledge. Wong (2021) argues for evaluation of prior knowledge which would inform teachers to apply relevant scaffolding mechanisms during lessons, otherwise lesson outcomes would be based on assumptions.

Evidence from participants demonstrated how technology affords learners opportunities and possibilities to meaningful learning. Of course, technology alone does not constitute creative learning, concepts mediation through digital tools and innovative strategy would be ideal for effective teaching and learning. What is key is the ability of teachers to use technology creatively to expand learners' understanding from basic to advanced level. This requires a systematic teaching approach which recognises learners as contributors of knowledge, understanding their background and building on what they know as a guide towards introducing what is not known.

6.4.3 Improve learner attention for active learning during Mathematics lessons

Learning is a cognitive process influenced by various social factors. Learning tools have long been introduced to enhance teaching and learning in the classrooms. With technology highly penetrating classrooms, teachers have found it enhancing or distracting learning. Most teachers have backed their reasoning based on their classroom context. Hence, some teachers have accepted and integrated technology in their teaching while others have rejected it to the core. Advocators of technology insist that the collaborative and interactive features of modern technologies bring about active learning (Cabrera-Solano, Quinonez-Beltran, Gonzalez-Torres, Ochoa-Cueva & Castillo-Cuesta, 2020). Active learning is also associated with high learner engagement. When learners are engaged, they pay attention to what they are doing. Cabrera-Solano et al. (2020) value technology because it engages, motivates, improves participation and reduces learners' anxiety. Participants in this study have shown how learners become attentive and excited for fiddling with the IWB during Mathematics lessons. Musina's explanation of learners possessing more skills than teachers serve as a good example of learners taking charge of their learning and becoming actively engaged by providing technical support.

Among other things, active learning exists when learner's curiosity is elevated, participation is meaningful and concentration level is high during lessons (Jesionkowska, Wild & Deval, 2020). This corroborates Makhado's explanation of using equations to draw graphs and predicting the shape of graphs on the IWB. On the other hand, Waterberg also showed how Geogebra software grabs learners' attention and improves their learning. Learners' ability to manipulate diagrams and fiddle with IWB icons has drawn their attention on how to navigate and locate interactive tools. Learners who engage with interactive tools would be more motivated and keener to collaborate and communicate where there are challenges (Jesionkowska, Wild & Deval, 2020). On the same note, Vhembe's view that learners' act of helping teachers technically is a sign of being attentive in class. Otherwise, they would not know where and how to intervene.

Learners' physical interaction with the IWB encourages them to pay attention to technical knowledge and content knowledge. Technology stimulates learners' concentration, and their performance improves because they are motivated by the physical and practical experience of fiddling with technology (Singhal, Kumar, Singh, Fuller & Gill, 2021). The IWB is counted as one of the modern technologies which promote high learner concentration for active learning. Mihai (2020) supports physical interaction with the IWB because he is of the view that the IWB stimulate and motivates learners through its multimodal features.

To further arouse learners' attention in IWB enabled classrooms, Erdener (2021) advocates for use of interactive multimedia content. Although most participants struggled to incorporate external programs into IWB usage, few participants managed to use Mathematics multimedia content and brought interactive programs (Geogebra) which afford learners with rich multi-face content projection. This research report has acknowledged both the physical and interactive nature of the IWB to improve learners' attention. Moreover, the recommendation by Gonzales and Gonzales (2021) of learners' attention being captured by the IWB's multimodality resonates well with the notion that active classroom participation can be realised provided there is effective integration of content, pedagogy and technology. Teachers' pedagogical skill of integrating the IWB effectively is also considered to be contributing highly to active learning. Hence, Erdener (2021) appreciates teachers' skills of using technology to foster active learning than technology itself.

Availing IWB in classrooms is not enough for active learning. Similarly, motivating learners without ensuring that they are fully engaged and focused would lead to passive learning. Therefore, teachers are encouraged to innovatively use the IWB to promote active learning and apply digital pedagogic practices which draws learners' attention. Otherwise, learning would still be passive and boring even in IWB enabled classrooms.

6.4.4 Conclusion

The discussion in this theme has shown that availing IWB in classrooms is not enough for active learning. Similarly, motivating learners without ensuring that they are fully engaged and focussed would lead to passive learning. Therefore, teachers are encouraged to innovatively use the IWB to promote active learning and apply digital pedagogic practices which draws learners' attention. Otherwise, learning would still be passive and boring even in IWB enabled classrooms. Participants' abilities of allowing learners to fiddle with Mathematics content on the IWB prove the existence of active learning practices in the classrooms. What stood out was the need for teachers to use IWB to move learners' thinking from average to innovative level. This is in line with constructivism proponents who advocate that knowledge is socially constructed and retained, active learning and assisting learners to acquire knowledge can be done scaffolding mechanisms.

6.5 The affordances of IWB augment interactivity in Mathematics classrooms

No one can dispute the IWB's interactive features which afford users opportunities to present content in many forms. The IWB's interactive features present prospects for users to use its technical interactivity and dialogic interactivity to achieve lesson outcomes (Bardakci & Ünver, 2020). In fact, the degree to which the affordances of the IWB are used would be dependable on the significance of the IWB towards the lesson. Those who choose to take advantage of the IWB's affordances would find teaching with IWB more relevant and benefiting while others would find it as an ordinary teaching tool which does not affect their teaching. Advocators of the IWB's interactivity like Yu (2020) considers learning to be more engaging and interactive in IWB enabled classrooms. The implication here is that learners' abilities are challenged as they participate in discussions and debates. Their collaboration pushes them to be high level thinkers since they reflect themselves through others.

Although the IWB presents interactive opportunities, limitations could still emerge based on various factors. As discussed previously, there are number of factors which could affect IWB usage. Among others could be teachers' inability to use the interactive and collaborative features of the IWB to improve learning. Therefore, poor integration of IWB's affordances could negatively affect learning if these factors are not carefully considered. Given the IWB's interactive and collaborative affordances of the IWB, teachers' pedagogic practices are entirely depended on how best they harness these affordances to enhance teaching and learning of Mathematics concepts.

6.5.1 IWB as an interactive tool in Mathematics classroom

The versatility of the IWB and its interactivity has been known to bring classroom interaction and promote active learning, and this has been proven beyond reasonable doubts. From this research report, literature review has highlighted what IWB can offer to our classrooms. Furthermore, the study has also shown how the use of IWB has influenced and transformed teachers' pedagogical practices in many instances. Although few participants could not take advantage of the IWB's interactivity to improve their teaching, there has been a fair usage of the IWB as an interactive tool amongst most participants. The IWB usage differed widely on their understanding of what it can offer for them.

Evidence from the participants showed limited usage of the interactive features of the IWB. Hence, some participants were using the IWB like a chalkboard. Based on Wujec-Kaczmarek's (2021) perspective, teachers who have not acquired necessary skills of using IWB would see it as a projector or a new version of presenting information to students. Even though participants showed interest in using the IWB as an interactive tool, there have been limited efforts in using IWB's software or online tools to improve interaction. Mopani and Waterberg are perfect examples of those who use elementary IWB tools to deliver Mathematics lessons. Less evidence was provided in terms of using IWB to present Mathematics lessons that require physical interaction with the board.

The IWB's capabilities to bring interactive lessons cannot be taken for granted (Gonzales & Gonzales 2021). Although participants' responses were in support of Gonzales and Gonzales (2021), their practices were not explicit in terms of using the IWB's ability to present Mathematics content that will foster interaction. Participants appreciated the IWB's capabilities of presenting Mathematics content in a diverse way. Vhembe went further to present puzzles which require learner-content interaction on the IWB. Scholars who support these practices like Cadamuro et al. (2020) insist that teachers should use ICT to stimulate interaction and improve learning opportunities. When IWB is adequately used as an interactive tool, learners' cognitive skills could be enhanced since content is presented through various modes. The multimodality of the IWB has benefits of fostering active learner engagement and classroom participation.

Poor usage of the IWB's interactivity has been emphasised to be producing boring and teacher dominant lessons. Wujec-Kaczmarek (2021) calls for teachers to improve ways of creating activities on the IWB to promote classroom interaction. Although participants showed the importance of using scaffolding mechanisms to boost learner participation and interaction, practical examples could not be provided for these practices. Among other things which participants mentioned as key to IWB usage was peer reviews based on concepts presented on the IWB. Participants insisted that presenting Mathematics content on the IWB encouraged discussions and debates on areas where their perceptions were different. To emphasise on the IWB's physical tools (pens, clickers, etc) mentioned in the previous chapter, creation of interactive activities on the IWB could ensure active participation and motivate learners to become academic achievers. In IWB classrooms where there is high learner-content and learner-learner interaction, knowledge is acquired easily due to access of rich multimedia content, active participation and collaborative experience.

6.5.2 IWB as a collaborative tool in Mathematics classroom

Collaboration is a social phenomenon which is highly recommended in organisations where there is shared vision, and the goal is set to be achieved as a collective. Although collaboration is fundamental in learning, it does not occur automatically, teachers still require creating strategies that enforce meaningful and fruitful collaborative means for their classroom contexts. With IWB penetrating Gauteng public township secondary schools, collaborative learning could be embraced especially where digital pedagogies are practised. The discussion by Boutefara and Mahdaoui (2020) on how the IWB can improve collaboration cannot be taken for granted. Evidence from participants in this study validates the notion that IWB can promote collaboration provided it is properly integrated within the school subject.

Features of the IWB require innovative and dedicated teachers who profusely harness its affordances to foster interaction among learners. Scholars have embraced collaborative learning through IWB since it has possibilities of promoting high thinking skills, social presence and acceptance (FWA, 2022). Modimolle's view of allowing learners to discuss and reflect on the concepts projected on the IWB serves as a practical example of facilitating active learner participation in class. Waterberg's response also aligns with Modimolle's view of using IWB applications to share Mathematics content and collaborate with other classes. Both participants valued the IWB's abilities to project and share information which could trigger debates especially when learners are given a chance to discuss and reflect on their views. Although most participants showed understanding on how IWB could assist in promoting learner collaboration, less was said about collaborative platforms which could inspire learners to work together and be actively involved during learning.

Wujec-Kaczmarek (2021) advises teachers to use IWB affordances to stimulate learning and scaffold learners on areas where lesson objectives seem too difficult to achieve. In a nutshell, teachers are encouraged to use the interactivity of the IWB to arouse learners' interest and create scaffolding mechanisms which would elevate learners thinking capacity. Once teachers could use the collaborative features of the IWB, learning would be active and free from teacher dominant practices. This is in accordance with Cadamuro et al. (2020) who believe that ICTs could foster high order thinking through dialogues, stimulate learning and improve social interaction among learners. Given the affordances of the IWB, the responsibility lies with teachers to bring communality within the learning environment and use these technologies as collaborative tools to improve active interaction and social presence.

Participants showed to be less knowledgeable about online tools which could foster collaboration in learning. In their explanation, they did not show how contemporary digital and collaborative teaching tools were used to foster active learning and high interaction. As Tran (2021) has suggested, collaborative tools such as blogs and wikis would encourage learners to collaborate outside the classroom context. Musina was the only proactive participant who used online social media platforms like WhatsApp to foster collaboration. This initiative was one of the innovations of reaching learners outside their traditional classroom environment. Although Musina does not categorically explain how WhatsApp was used on the IWB to foster collaboration, Alharbi and Khalil (2022) regard this initiative as a good strategy for in cooperating blended learning. The assumption in Musina's case is aspects that cannot be understood in class can be further explained on WhatsApp.

Evidence from participants showed minimal usage of IWB to foster collaboration. Participants' explanation showed lack of experience on how IWB tools could be used for collaborative purposes within and outside the classroom context. Teachers could not use the IWB to foster online collaboration through WEB 2.0 tools for learners. Therefore, the IWB was not used to facilitate learner online presence regardless of its rich collaborative affordances.

The IWB's affordance to augment interactivity is purely dependent on how teachers use this technological tool to foster interaction and collaboration in the classrooms. The degree to which IWB would be used as a collaborative tool would be reliant on teachers' knowledge and skills of pedagogically integrating IWB within the school curriculum. There are no doubts that the IWB's interactive and collaborative features of the IWB could create active learning. It must also be noted that teacher competences and other factors discussed earlier remain important dependencies towards ensuring that Mathematics classrooms become productive learning spaces.

6.5.3 Conclusion

This theme has discussed how the affordances of IWB could augment interactivity in Mathematics classroom through teachers' intervention. The IWB's affordance to augment interactivity is purely dependent on teacher's capability influenced by both internal and external factors to use this technological tool to foster interaction and collaboration in the classrooms. The degree to which IWB would be used as a collaborative tool would be reliant on teachers' knowledge and skills of pedagogically integrating IWB within the school curriculum. There are no doubts that the IWB's interactive and collaborative features of the board could create active learning. Limited usage of the IWB's affordances could result in boring practices where the IWB is used to project context with less interaction. Those who do not take advantage of IWB affordances would limit interaction and collaboration within classroom walls. Such practices would result in learning being dependable on the actual presence of teachers and learners at school.

6.6 Synthesis of the Findings

The findings from all four themes have shown interconnection and correlation in terms of explaining teachers' preparedness and attitudes towards IWB usage. As discussed earlier, usage of IWB is influenced by many factors and teachers have prioritised these factors according to their preferences. Most of the participants dimmed knowledge and skill of using the IWB as a prerequisite towards being effectively integrated into the school content. On the other hand, some participants valued their attitudes as key drivers of IWB usage. Although basic skills are needed to use technology, participants argued that internal factors such as attitudes could determine the willingness to drive the use of technology. Teacher experience came out to be another important aspect of technology usage. In fact, most of the participants regarded experience of using IWB as mere exposure to technology. Also, participants could not value TPACK knowledge as key contributor to the experience of using technology. A mere exposure cannot be equated to experience; those who possess TPACK knowledge and are exposed to technology would be deemed having the necessary experience of using technology.

To further deem a person ready to teach with IWB, participants reiterated that digital teaching strategies are important in IWB enabled classroom. Failure to acquire or apply teaching strategies that promote learner-centeredness and diverse learning would result in poor classroom management or practices. Although few participants struggled to apply good teaching strategies for IWB enabled classroom, most participants used features of the IWB to create learner-centred lessons. Participants further recognised constructivist-oriented practises as significant towards being prepared to teach with technology. Applying digital teaching methodology is not enough to be regarded as being prepared to teach with technology, teachers must ensure that in any learning situation, there is active learning, knowledge is retained, and learners' knowledge is elevated. Evidence from participants showed learning as active since learners were taking charge of their learning space. As previously mentioned, teachers' preparedness would depend on teachers' innovation to use IWB to foster individualised, active and learner-centred learning.

Adopting teaching strategies and practices that support IWB enabled classrooms would not be enough without understanding how the affordances of IWB could be used to promote interactivity in the classroom. Active learning is realised when learners interact with content, peers and teachers. Interaction is not limited to physical interaction; technology is affording learning to exist outside the school environment. Participants attempted to use the IWB to promote interaction and collaboration; however, their efforts were limited to the classroom context. There was no evidence of expanding the use of IWB as an interactive and collaborative tool outside classroom walls. When it comes to teachers' readiness with respect to applying the affordances of IWB to augment interactivity, most of the teachers were found wanting.

The extent to which teachers' preparedness and attitudes affect the effectiveness of using the multimodal affordances of the IWB into teaching has been discussed at length in this chapter. Evidence from the participants showed that teachers' readiness is not influenced by a single factor. Moreover, this research has shown how internal and external factors of using IWB contribute towards teachers' readiness. The relationship between the findings shows the importance of each theme towards teachers' readiness and attitudes towards IWB usage. Figure 8 below shows the interrelation of themes towards teachers' readiness to use IWB.

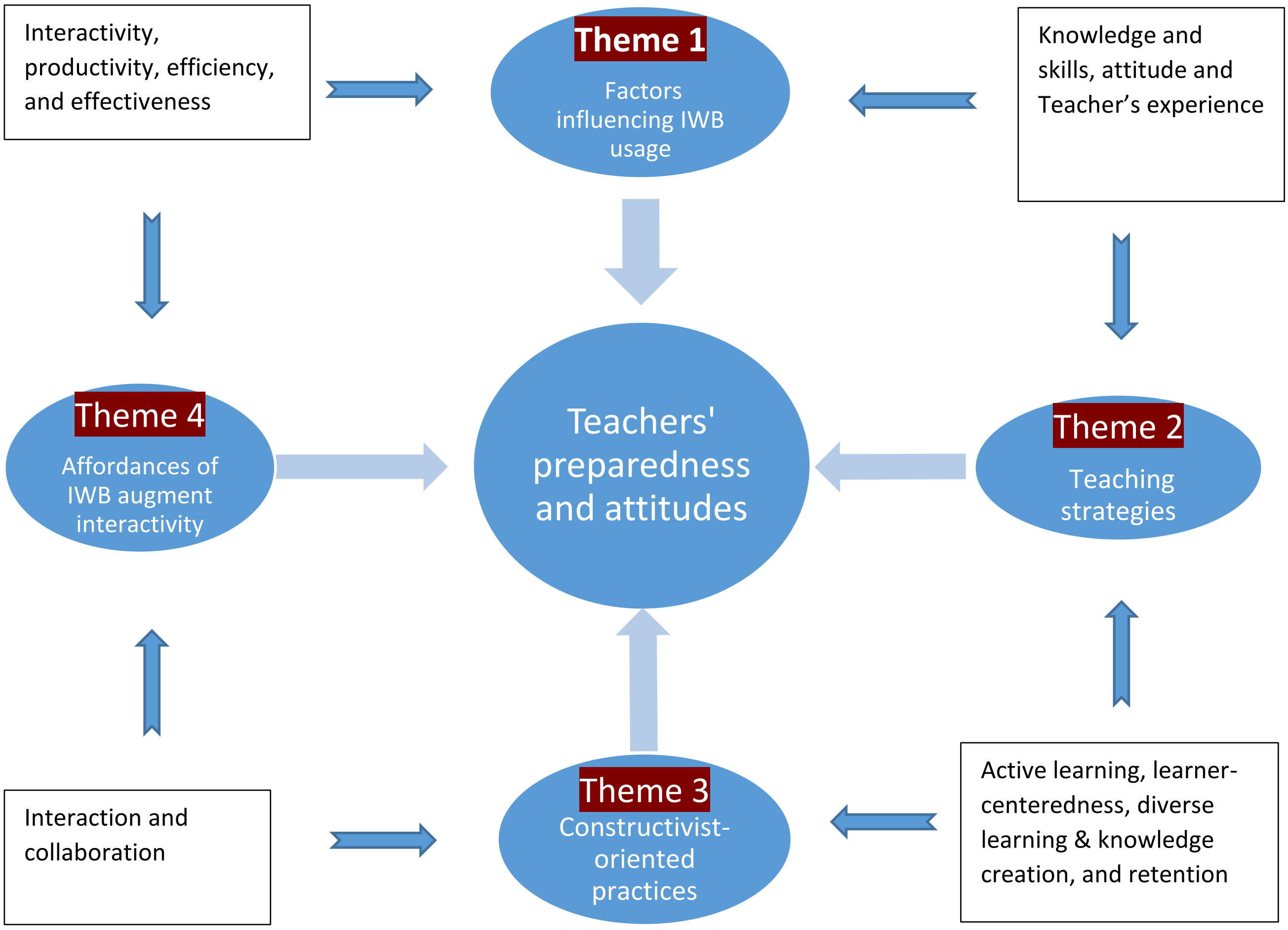

Figure 8 Thematic Relationship of Findings

The graphical representation of the themes above shows how they impact each other and how they impact on the teacher preparedness. Although each theme affects teachers' preparedness and attitudes differently, there is a significant contribution from all the themes. The implicit or explicit relationship between the themes shows how teacher's preparedness and attitudes towards IWB usage is influenced by interconnection of various aspects (themes). The connection between Theme 1 (Factors influencing IWB) and Theme 4 (Affordances of IWB augment interactivity) plays a significant role towards influencing teachers to use IWB for teaching. One would argue that the connection between these themes would also influence teachers' preparedness to use IWB for teaching. Similarly, the relationship between Theme 1 and Theme 2 (Teaching strategies) also contributes towards teacher's preparedness towards IWB usage. Equally important, the relationship between Theme 2 and Theme 3 (Constructivist-oriented practices) as well as the relationship between Theme 3 and Theme 4 would also contribute significantly towards teachers' preparedness to use IWB. The connection between the themes shows how one cannot conclude by saying teachers are well prepared and have good attitudes towards using IWB to teach by focusing only on the affordances of technology, their teaching practices, attitudes, skills and knowledge or classroom practices. The interconnection of the above-mentioned themes has created a great argument that teachers' preparedness and attitudes towards teaching with IWB is dependent on various factors.

6.7 Conclusion

This chapter has presented findings from chapter 5 and has been linked to the four themes which were discussed lengthily. The discussion of the themes aimed at addressing research questions. This chapter discussed findings with reference to the generated data and were supported by literature and the theoretical framework. The discussions gave clear understanding of the topic and showed how teachers used IWB to teach Mathematics in Gauteng township secondary schools.

Findings showed different practices of how teachers use IWB in Mathematics classroom. Moreover, the study showed how usage of IWB is dependable on teachers' preparedness and attitudes towards IWB. Teachers' various interpretation on key aspects which contribute towards IWB usage has showed different understanding of what is deemed as key factors or influencers of technology integration.

The challenges of using limited online interactive and collaborative IWB tools could be traced back to either lack of knowledge and skills of using the IWB, no understanding of the affordances of IWB or inability to perceive the benefits of IWB accordingly. Furthermore, poor integration of IWB could also be traced to lack of applying correct pedagogies which suit the classroom technology in use. A non-coherent important set of knowledge (Technological Pedagogical Content Knowledge) has resulted in some teachers blundering in their teaching practices. Many teachers relied on their exposure to IWB as an experience than having skills and knowledge of integrating IWB (TPACK) with Mathematics curriculum. Participants considered and counted their frequency of using IWB as an experience.

The findings further disclosed that teachers' readiness and attitudes to use IWB is influenced by internal and external human factors. Understanding the nature of technology and how it could enhance teaching and learning in a classroom context is of high importance. As previously argued, possessing more attributes of one theme and neglecting others would result in poor integration of IWB which could be equated to less readiness on IWB usage.

This chapter has given synthesis of the findings to show interconnections of the themes. The links between the themes demonstrated that teacher preparedness and attitudes cannot be addressed by a single factor or aspects. Analysis of the findings has shown gaps on how teachers in Gauteng Township schools integrate IWB into Mathematics content. Furthermore, the results have also shown that although there is fair usage of IWB in Mathematics, classrooms teachers should be thoroughly prepared to use IWB by equipping them with the necessary skills and knowledge, shape their attitudes and empower them with constructivist-oriented teaching approaches and assist them to use adequate teaching strategies that matches available educational technologies in Mathematics classroom.

The next chapter gives a summary of the findings and concludes the study. Recommendations based on the findings of this study are briefly discussed at the end of chapter 7.

Chapter 7: Reflection, Conclusion and Recommendation

7.1 Introduction

The previous chapter discussed the findings of the study in relation to the research question which seeks to understand teachers' preparedness and attitudes towards teaching with IWB in the classroom. The study is located within the pragmatist paradigm and aligns itself with a social constructivist learning theory. A mixed method approach was used to give a synthetic interpretation and analysis of the study which gave clear guidelines on achieving the study's goals.

This chapter gives an overview of the findings and goes on to reflect on the findings. Recommendations and limitations of the study are clearly spelt out in this chapter. Suggestions on future studies brought in this study would broaden knowledge of preparing teachers especially within the IWB enabled schools.

Just to recap, the study aimed to address the following research question and sub questions.

Research question

How teachers' preparedness and attitudes affect the effectiveness of using the Multimodal Affordances of the Interactive Whiteboards into teaching of grade 11 Mathematics content?

Sub questions

1. What links do Mathematics teachers make between multimodal affordances of Interactive Whiteboards and the constructivist-oriented practices in the teaching of Mathematics concepts at Grade 11?
2. How do teachers' attitudes affect the integration of IWBs in the teaching of Mathematics content in Grade 11?
3. How do Grade 11 Mathematics teachers use IWBs' multimodal affordances to increase student–content, student–teacher, and student–student interaction in Mathematics classrooms?

7.2 Review of the main findings

From the discussions and analysis drawn from chapter 5 and 6, the following main findings emerged and were discussed in relation to the research objectives.

7.2.1 Factors influencing IWB usage in teaching Mathematics content

The study showed evidence of teachers having limited skills and knowledge of using IWB to teach and that they acquired these skills over time as they interacted with the IWB. Hence there was lack of innovative ways of using the IWB to teach mathematics. Participants valued the importance of having knowledge and skills of IWB, otherwise, usage would be impossible. Although skills and knowledge were highly ranked among other factors, integration of sets of knowledge such as TPACK was not clearly pronounced. Majority of teachers perceived IWB as the most favourable technology suitable for teaching of Mathematics. Teachers had carried different attitudes towards the IWB but with time, most of them found IWB useful and there was fair utilisation of IWB as a teaching tool. Although they carried positive attitudes towards IWB usage in Mathematics classrooms, the expectation was that, with time, teachers should perfect their skills of using IWB to enhance communication and interaction. However, evidence from this study showed that those with a lot of experience had similar challenges as novice teachers.

7.2.2 Teaching strategies for Mathematics classrooms with IWB

Findings showed that during the initial stage of using the IWB, teachers struggled a lot with integration of Mathematics content and technology. Teachers who embraced good teaching strategies aligned to Mathematics content and IWB started developing good teaching strategies throughout their teaching experience. Even those who used ordinary features of the IWB to enhance their teaching appreciated this tool. Most participants were aware of the multimodality of the IWB and felt it is important to use features of the IWB effectively to ensure inclusivity during Mathematics lessons. Most teachers were not innovative users of the IWB. Moreover, participants could not use Mathematics online content that would enrich and trigger learners' inspiration to learning. Thus, there is a need to capacitate teachers with knowledge, skills and teaching strategies that will enable them use IWB's features to promote learner-centred approach that encourages self-driven and interactive learning.

7.2.3 Constructivist-oriented practices in Mathematics classrooms with IWB

Major discoveries here are the teaching strategies that teachers ought to apply to ensure that there is knowledge retention, learners' knowledge is improved from basic to concrete and that their participation is active throughout the learning process. Teachers' pedagogical skills are critical especially in technology enabled classroom because they must match both the subject content and the classroom setting. There are major concerns about the extent to which teachers in this research have applied TPACK knowledge in their teaching. Evidence shows that there were mismatching pedagogies. Although constructivist principles were applied to promote active learning; learner centred approach, peer learning and content engagement collaborative platforms could not be explored to expand learning horizon. Evidence from participants showed few strategies of moving learners from the known to unknown concepts, means of retaining knowledge retention and ways of improving their attention for active learning. According to Alsarayreh (2021)'s views, constructivist practitioners would use technology to improve knowledge construction and retention. From a constructivist perspective, these technologies are artefacts which facilitate learning within the education environment (Saleem, Kausar & Deeba, 2021).

7.2.4 The affordances of IWB augment interactivity in Mathematics classroom

The key findings on this section are that the IWB presents opportunities for users to interact and collaborate through its advanced features. However, teachers in this study have demonstrated that usage of IWB were limited to classroom experiences. Evidence from participants showed lack of innovation and failure to expand classroom walls to engage learners outside their school environment. As correctly put by Boutefara and Mahdaoui (2020), interaction should go beyond classroom experience. A blended approach encourages inclusivity and social presence and ensures that there is constant interaction and collaboration in and outside the classroom.

The department expect teachers to do well in their teaching careers, witnessing experience teachers struggling with teaching tools shows gaps within the system. Poor learner performance and low ranking in Mathematics education could be linked to many factors. Evidence from this research points lack preparedness and negative attitude towards technology as hindrance to innovative teaching. Although the White paper on e-Education policy put emphasises on the use of technology to afford learners 21st century skills, teachers seem to be battling to mediate content with the technologies. As such, the reluctance to use technology could be too high and learners would be denied opportunity to learn in a diverse and innovative manner.

7.3 Implications of the study

The study's findings have numerous implications on the use of IWB as a pedagogic tool to enhance the teaching of Mathematics in the classroom. Moreover, findings about the extent to which teachers are deemed ready to teach with IWB has implications on how teachers should be capacitated for modern teaching. Discussions on teachers' attitudes in this study could possibly have high impact on how teacher trainings should focus on internal or external human attributes when they use technology.

Even though teachers had used IWB for teaching and learning, most of them valued technological skills as a great influencer for integrating IWB into Mathematics lessons. The pedagogical knowledge and skills on how technical knowledge of the IWB could be merged to deliver content productively continued to lack amongst participants. In other instances, there were mismatching teaching approaches. This led to poor integration and insufficient adoption of IWB as a teaching tool. However, teachers got used to the IWB as a teaching tool with time. The findings suggest that they gained more technical skills faster than the pedagogical skills. It is for this reason that they could not regard TPACK knowledge over technological knowledge. The implication of not having correct Technological Pedagogical Content Knowledge is that technology could serve as a distractor for teaching and learning in the classroom. Focus could be on the technology other than on the learning outcomes and enhancement of learning through those technologies. Such experiences would result in poor pedagogic practices which yield poor learner performance (Ammade, et al., 2020).

Another implication of the findings is teachers utilising IWB to promote communication, collaboration and classroom interaction. The challenge here is, due to lack of innovative teaching strategies, interaction and collaboration happen within the school environment only. Teaching and learning were not expanded outside school environment. Incidences like this could promote teacher reliance condition which could hamper learning process. More so, using IWB like a blackboard or projector shows poor integration and adoption of technology. This implies that teachers have limited understanding of Mathematics online tools and platforms which could foster interaction and collaboration beyond the classroom context. Consequently, learners' social presence and interaction would be minimal due to teachers failing to use the affordances of IWB augment interactivity**.**

7.4 Reflection of the findings

With reference to the finding discussed in chapter 5 and 6, it is of utmost importance to reflect on major aspects within these chapters. Firstly, one can't deny efforts and strategies deployed by the GDE to capacitate teachers with the necessary skills of teaching through IWB. The introduction of ten pillars as a strategy to transform the education system became a significant game changer within the education system. As correctly articulated in chapter one, to address skills shortage, teacher development pillar was introduced and series of trainings served as development strategies. The expectation here was that, when teachers are trained, they would be ready to implement or teach with IWB without challenges.

Before this research was conducted, the assumption was that, with series of teacher development trainings on IWB usage conducted by the GDE, teachers would find it easy to integrate IWB into their teaching. The understanding was that, with IWB being installed in schools and teachers receiving basic training on these devices, integration would be simpler. Availability of technical staff members in township schools to offer support backed the assumption that teachers would indeed find it easy to teach with IWB. It was assumed that technical challenges will be dealt with immediately thus teaching and learning will not be disturbed. However, the findings showed a different picture as compared to what was initially assumed.

Most of the teachers lacked correct knowledge of integrating IWB into their teaching. The white paper on e-Education's aim of providing technological ICT resources in schools to accommodate different learning and teaching styles could not be achieved as expected. The White paper on e-education's call to improve "the quality of learning, teaching and deliver lifelong learning" could not be achieved by many (White Paper on e-education, 2003). There were instances of mismatching pedagogical approaches which resulted in poor learner achievements. Teachers' readiness level is questioned here because of neglecting other key influencers of technology integration. As previously argued, high advancement in technical skills does not equate to high technology integration. Both internal and external factors which influence technology integration should be highly considered. Teachers' preparedness to usage a technology is dependent on their adoption and adaptation of these factors because it cannot be attributed to a single factor.

With reference to these reflections, one could only hope that a better approach could be implemented by the GDE to adequately prepare teachers without making assumptions that giving teachers technological skills would equate to teachers being able to develop correct pedagogical approaches which would align to technologies.

7.5 Gaps identified in teacher preparation process

As previously highlighted in the background, introduction of paperless classroom in Gauteng schools was one of the initiatives which left a mark to the South African education landscape. Although most provinces saw Gauteng Education Department progressing with technology education, evidence from this research shows that there are gaps in terms of teachers being prepared to teach with technology. Judging from a distance, one would assume that Gauteng teachers were well prepared to teach with existing technologies. As one zooms into classroom practices, it is evident that there are lot of challenges since the Paperless Classroom solution was introduced.

Although there were many challenges since the inception of technology education in Gauteng, this research focused on the preparedness of teachers and their attitudes to teach through IWBs. It cannot be disputed that the GDE has trained teachers on IWB usage during the initial stages of introducing technologies in the classroom. Evidence from participants showed that training focused on the technical part of IWB other than training them on how to integrate their subject with technology itself. It is not a mistake that most teachers valued ICT skills as key factors needed for ICT integration.

Zooming into series of trainings which took place during the implementation phase of the project, some teachers have argued that some of the aspects of IWB were self-taught. This shows that training was limited to the trainer's understanding of the IWB. This can be backed by the fact that the GDE has used Teacher Development facilitators and Matthew Goniwe trainers who are not subject content specialist to train other teachers. Regardless of the trainer's speciality and level of content knowledge within their subject discipline, trainers would be allocated schools to train. That is why some teachers used basic functionalities of the IWB to teach. Teachers who benefited from trainers who used Mathematics programs such as Geogebra were lucky to have experienced such training because majority were offering basic ICT skills.

Teacher preparedness in technology education remains a misery especially where technology integration is not clearly understood. Evidence from participants showed lack of integration skills and knowledge on how to integrate subject specific concept to a technological program. Although teachers were fumbling in terms of IWB usage and integration, one can argue that in instances where proper integration is achieved, active and innovative learning could be achieved with ease. Improvement in Mathematics education would not be a bridge too far if learners take charge of their learning space at any time regardless of their learning context (Saleem, Kausar & Deeba, 2021).

Evidence from the report showed that teachers lack pedagogical skills of integrating IWB into Mathematics content and those with skills, they are not innovative enough to improve learner engagement and collaboration outside the classroom. What is more concerning is lack of plans to capacitate teachers on ICT integration. Even after technical training was rendered during the initial stage, teachers kept on developing themselves throughout their teaching career. Also, they continued to fumble throughout the integration process because their self-taught skills were not pedagogically structured for IWB integration purposes. There are policies and strategies that guides government official on teacher development, what worries further is whether there will ever be time where teacher training and development is prioritised to mitigate poor ICT integration on the ground. If poor ICT integration is left as is, the status quo around Mathematics education will also remain unchanged.

7.6 Contribution of the study

From the existing vast body of knowledge within ICT integration scope, it is important to acknowledge the contribution of this study especially from a South African context where technology integration partially exists in township schools. As mentioned in the previous chapters, although some Gauteng based schools are well resourced, preparing teachers to teach with IWB is still a prerequisite towards supporting full ICT integration.

The study has interrogated the UTAUT model towards teacher preparedness on IWB usage in Mathematics curriculum. The findings presented the significance of restructuring the UTUAT model towards teacher preparedness. From UTAUT model by Venkatesh, Morris et al. (2003), it is important to note that experience forms part of the four variables which contributes towards technology usage. Of course, these variables are not isolated from the four major constructs of the UTAUT model which to a large extend, influence behavioural intentions and technology usage. The study has critically outlined two proponents of experience which collectively contribute towards the four constructs of UTAUT model. The original UTAUT model does not clearly specify what constitutes experience; hence this study has suggested the proponents of experience as a combination of TPACK knowledge and experience of teaching with IWB. Figure 3 in chapter 3 gives a clear description of the teacher preparedness and usage of IWB model.

The study has given a clear distinction of user experience on technology usage and its influence within curriculum delivery. Although scholars such as Bonafini and Lee (2021) have supported users with technology experience to be having benefits of teaching with technology well, the study has further interrogated teachers' experiences because it meant different things to different users. An example can be drawn from chapter 6 where sets of knowledge (Technological Content Knowledge "TCK" & Technological Pedagogical Knowledge "TPK") were briefly discussed. What is deemed more important is acquisition of experience through possessing adequate knowledge and skills using multiple technologies to improve teaching strategies and technology adoption (Ardıç, 2021). And through this experience, Anderson and Putman (2020) are of the view that teacher experience will boost their confidence and willingness to use technology. When technology adoption and usage are high, learners are likely to benefit from rich digital media content and digital pedagogies which have a potential of promoting constant communication and collaboration.

Given the number of internal and external factors affecting technology usage, the study has also contributed extensively to the existing knowledge particularly from a South African perspective. It is important to highlight that although the focus was on the preparedness and attitudes of teachers towards IWB usage, the study went beyond to discuss classroom context and complexities. Hence, a call for teachers to be innovative in their teaching approaches to use scaffolding mechanisms ranging from multimedia aids to practical interaction beyond classroom boundaries (Aldalalah, 2021).

Within the field of technology education in South Africa, there are quite reasonable suggestions on how IWB influences teaching and learning in the classroom. Many scholars have shown benefits of educational technologies and their influence in a classroom context. It was not surprising to see the implementation of Paperless Classroom solution in Gauteng township schools. However, what emerged during the implementation phase is the unavailability of a framework which should governs the project from its inception to the implementation phase. The Gauteng Education government was tip towing between the Guidelines on the Management and Usage of ICTs in Gauteng public Schools which was formulated to address challenges of Gauteng online strategy and the White Paper on e-Education. Still, with these documents being in place, schools' contextual factors were not filtered in. The implementation was rushed without full stakeholder engagement and advocacy especially from the initial stages. From Goodyear's (2020) perspective, any project or solution requires a practical theory of how it should be administered and within which parameters. These would make one understands how practices and settings would influence one's project. Judging from challenges that emanated from the Paperless Classroom Solution, it is certain that there has not been any deep analysis of project-based design and implementation based on the practical South African context. One would conclude that Paperless Classroom solution could be one of those solutions that are borrowed from developed countries without being interrogated whether they would suit the South African curriculum.

With reference to the challenges of preparing teachers to use IWB for teaching Mathematics concept, the study contributed to the existing knowledge by suggesting a framework which could serve as a guideline for IWB integration. The framework has considered South African education context and would be best administered where a new solution or project is about to be implemented. Although there are instances where solutions are already implemented, this framework could also serve as a guideline or reference to any existing project. The framework is mainly suitable for integrating IWB with Mathematics concepts.

Where there are technological tools which could facilitate knowledge acquisition, one would argue that content knowledge should be understood with ease. Although technology alone would not solve classroom challenges, the study still argue that we need teachers who are well prepared to teach with IWB. Hence the framework suggests 13 stages which could prepare teachers to fully integrate IWB into their teaching. Stages are divided into phases; stage 1 to 3 is the description and introduction of subject content phase. This is a stage where you identify personnel and your goal. Moreover, what ought to be taught (subject content) is merged with relevant subject specialist. Stage 4 and 5 are the technology introduction phase which focuses on the medium to be used to deliver content. One should have a clear understanding of what the technology is about, what skills and knowledge should teachers have about technology and understand what technology can offer for teaching and learning. Stage 7, 9 and 12 are supporting system phase which focuses on scaffolding mechanism for development and support of teachers throughout technology adoption and adaptation. And lastly, stage 6, 8, 10, 11 and 13 are technology integration phase. This phase is the ultimate phase where monitoring and support is emphasised for the purpose of having innovative technology integration within Mathematics curriculum. Depending on the education contextual factors; these stages might be applied interchangeably at the same time and or at different phases. A full representation of this framework is depicted by figure 9 below.

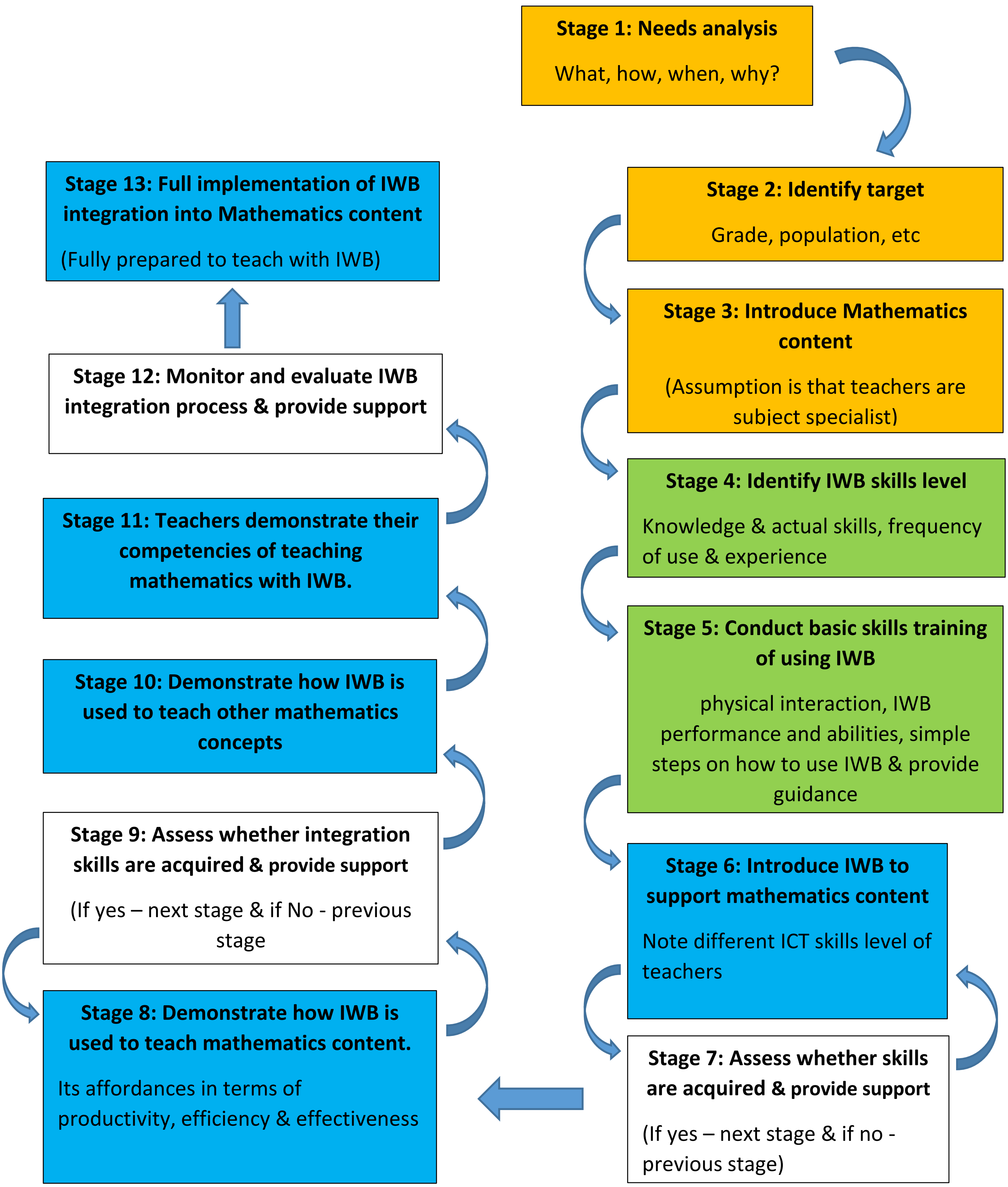

Figure 9 Teacher preparation for IWB integration within Mathematics content framework

introduction phase, stage 7, 9 and 12 are supporting system phase and lastly, stage 6, 8, 10, 11 and 13 are the technology integration phase.

Stage 1: Needs analysis stage

This is in the initial stage which requires planning and identification of what must be done. It involves addressing questions such as: what is needed? For what purpose? Why is it needed? And so forth. At this stage, you must identify a problem to prepare and plan for a solution which would address the problem or challenge. A clear plan on how and when the plan should be outlined is key and must be shared with all stakeholders.

Stage 2: Identify target

From the project formulation stage, it is very important to identify the level which IWB will be introduced. Specific technologies would suite specific grade/level or population. Every program or solution requires to be targeted to the right participants.

Stage 3: Introduce Mathematics content

Upon identifying the target group and level, is important to introduce Mathematics concept to be taught with IWB. Technology is used to deliver content not vice versa, therefore is important to identify what would be delivered before IWB is introduced. The assumption here is that teachers are subject specialists.

Stage 4: Identify IWB skills level

This includes conducting feasibility study to identify knowledge and skills possessed by teachers. Part of the requirements in this stage involves identifying frequency of use and teachers' experience on the use of existing or other technologies.

Stage 5: Conduct basic skills of using IWB

Before one can start thinking about basic skills, it is crucial to ensure that users have access to IWB. Training users on IWB skills without access would be a futile exercise. Users should have a physical interaction with IWB and be exposed to the affordances of IWB through systematic procedures. Understanding IWB and knowing what is capable of could change how users perceive it.

Stage 6: Introduce IWB to support Mathematics content

It is key to understand how IWB is used to support content delivery. Introducing programs and features of the IWB to deliver Mathematics content gives bigger opportunities of mediating Mathematics content better.

Stage 7: Assess whether integration skills are acquired and provide support

Determining successes and challenges forms part of monitoring processes in this stage. Where skills fall short, support is provided.

Stage 8: Demonstrate how IWB is used to teach Mathematics concepts

Now that users are familiar with IWB, it is critical to understand which programs or features of the IWB could be used for Mathematics concepts. More practical demonstration of the IWB's features is done to present Mathematics content in various forms. Variety of programs could be introduced in this stage to ensure flexibility and creativity.

Stage 9: Assess whether integration skills are acquired & provide support

Integration is expected to be at an adoptive level since IWB is used on few Mathematics concepts. Although the expectation is at elementary level at this stage, it is important to gauge the level of integration so that support can be provided where necessary.

Stage 10: Demonstrate how IWB is used to teach other Mathematics concepts

IWB is used on a wide range of topics to promote efficiency and effectiveness. Practical exhibition of the IWB's capability is done to promote productivity. The IWB gradually becomes inseparable from the Mathematics content since the same content is delivered through IWB daily.

Stage 11: Teachers demonstrate their competencies of teaching Mathematics with IWB

With knowledge and skills acquired through trainings and demonstrations, teachers are expected to apply their teaching through IWB. Upon being supported and guided through the process, the expectation is that they should be appropriate users of the IWB. At this level, the assumption is that they have adopted and adapted to the new way of teaching Mathematics with IWB.

Stage 12: Monitor and evaluate IWB integration process & provide support

Teaching with IWB is a process, hence it is crucial to provide constant support where it is due. Of course, support can only be provided when integration level is not satisfactory. At this level, instructors are required to evaluate the integration process and give necessary guidance.

Stage 13: Full implementation of IWB integration into Mathematics content

This is the final stage, which is assumed that users are innovative, effective and efficient in their IWB teaching approach. At this level, users are applying appropriate methodologies that are inclusive of both IWB and Mathematics content. At this stage, IWB is inseparable from Mathematics content. The assumption is that, through innovative ideas, teachers can use IWB to improve collaboration and communication outside the classroom setting. Such teachers are deemed to be fully ready to use and integrate IWB in their teaching of Mathematics content.

Considering the level of unpreparedness of teachers in using IWB to teach Mathematics, the framework will assist implementers of IWB programs and other technology programs across levels of authority. As previously mentioned, the flexibility of this framework makes it adoptable at different phases of the project or program (prior implementation, during implantation and post implementation) because it also serves as a guide for IWB integration within Mathematics curriculum. What is crucial is the integration of IWB by well-prepared teachers who aim to deliver quality teaching.

7.7 Recommendations

Considering the implementation of various ICT programs in Gauteng schools, one would argue that technology integration still lags due to numerous factors. Technology adoption and adaptation seem to be at different levels due to various reasons ranging from access to ICT, skills and knowledge, teacher preparedness, attitudes or teacher trainings. Provincial education departments have brought many technology programs for almost three decades aiming to improve teaching and learning, but South African education is still ranked amongst the poorest countries regardless of its economic developments (Mlachila & Moeletsi, 2019). Considering the findings, I am putting forward the following recommendations to improve ICT integration initiatives.

Any ICT initiative should be driven by a policy document which recognises South African education context especially the nature of resources (both human and physical) in place. From a strategic level, policy makers and implementors should be cognisant of various factors (economical, political, financial, social, etc) which could hinder implementation of any ICT solution (Ali, 2020). The contextual factors on the ground could hinder implementation of programs. Crime could be one of the factors which contributed to failing of many projects and program. Apart from crime, many programs are slowly dying because they were poorly conceived, and government could not continue funding them. As a result, the government continues to invest in programs or projects that are not sustainable and with no future succession plan.

Implementation of any new program must be piloted for few years and rolled out in phases before it can be fully implemented in all schools (Pearson, Naylor, Ashe, Fernandez, Yoong & Wolfenden, 2020). This would ensure that stakeholders learn and identify challenges and good practices emanating from the program. Although the Paperless Classroom solution was implemented in phases, there was no time to learn since phases were introduced a year after another.

A feasible study should be made for any ICT initiative to avoid recurring mistakes done by previous political administrators. Monitoring and evaluation be incorporated to gauge and determine the pact of the program. Where things are falling short, change management and other mitigating factors should be brought to play. Any political decision must be accompanied by a scientific proof that the idea would be implementable from a South African education context. Stakeholder engagement is key because it would ensure that there is common vision, buy-in and commitment to any program.

Before any ICT program can be rolled out, teachers must be thoroughly prepared to fully adopt and adapt to the program concerned. This requires trainers who are technologically and pedagogically competent to mediate subject content for teaching and learning. A one size-fit-all training approach would make teachers suffer from mismatching pedagogies and poor usage or non-usage of technology. A systematic training approach which gradually moves teachers from one level to the other would be ideal to capacitate them throughout the years. These capacity sessions should be aligned to teachers' subjects for relevance and accuracy, otherwise teachers would not find technology integration useful.

7.8 Limitations of the study

This research study had a potential of providing interesting results about the preparedness and attitudes of Gauteng Mathematics teachers towards integrating IWB into Mathematics curriculum. However, being guided by the University's PhD research course programme, the researcher was constrained to focus on only five schools. The study aimed at establishing how teachers' preparedness and attitudes affect the effectiveness of integrating IWBs into teaching of grade 11 Mathematics content. Moreover, only grade 11 Mathematics teachers in the five schools participated in this research project. The researcher would have liked to include all teachers in the IWB enabled township schools but due to time constraints, the study has not catered for all users of IWB.

7.9 Further research suggestions

To further expand on the findings and recommendations of this study, more research can be conducted on how teacher preparedness on the use of IWB affects learner performance. The scope of the research would probably be expanded to cater for learners because the researcher would want to know more about their classroom performances and academic achievements. This would surely show how teachers' daily classroom practices affect learners' way of acquiring and applying knowledge in a classroom. Classroom observations would give a clear view of classroom practices, interactions and pedagogies applied during the lessons. A deeper analysis from this research would probably suggest strategies which would best enable teachers to integrate IWB to improve curriculum delivery which eventually would result in quality education which produces competent learners.

7.10 Conclusion

Drawing from the main findings, discussions, contributions and recommendation of this study, it is only fair to conclude that the study has fairly contributed to the body of ICT knowledge in South Africa. The study has addressed its aims of understanding teachers' preparedness towards the integration of IWBs as pedagogical tools in the teaching of grade 11 Mathematics content. A conceptual model for teacher preparedness and usage of IWB (drawn from UTAUT) model was suggested to address preparedness to use IWB to teach Mathematics. The study went further to suggest teacher preparation for IWB integration within Mathematics content model which serves as a guide for integrating technologies to subject content.

In trying to find out if there are any relations between teachers' attitudes and the way in which IWBs are integrated in Mathematics lessons, the study provided evidence of how human internal factors influence one's attitude. Participants' belief systems, values, perceptions, understanding and experience of using IWB to teach Mathematics has shaped their attitudes towards using IWB as pedagogical tool. Participants held different beliefs (IWB is a time-wasting tool, IWB is a plug and play tool, etc) and assumptions about IWB. These assumptions changed overtime, and this has resulted in their attitude changing positively. To understand how Mathematics teachers use the multimodal affordances of IWBs to engage learners to teach Mathematics concepts, the study has argued for application of digital pedagogic practices and constructivist-oriented approaches which promote interactivity, collaboration and active learning.

To address teacher preparedness to teach with technology, one can only recommend a strategy that recognises proponents of Teacher preparedness and usage of IWB model coupled with the implementation of Teacher preparation for IWB integration within Mathematics content model. These commendations do not negate the scrutiny of contextual factors on the ground before an ICT program can be implemented. The study showed lack of structural systems to implement technology enhanced classrooms to support the teaching of Mathematics subjects. With Mathematics being abstract by its nature, honour lies with those who decide on the technological solutions to be rolled out to support innovation and contemporary teaching and learning.

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Annexure A

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Montjane

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: H21/05/31**

PROJECT TITLE	Mapping multimodal affordances of the Interactive Whiteboards into teaching of grade 11 mathematics content: A case study of five Gauteng township secondary schools
INVESTIGATOR(S)	Mr V Montjane
SCHOOL/DEPARTMENT	Education/
DATE CONSIDERED	21 May 2021
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	12 July 2024

DATE 13 July 2021 **CHAIRPERSON** ______________________
(Professor J Knight)

cc: Supervisor : Dr R Dlamini

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

______________________ 13 / 07 / 2021
Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Annexure B

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**18 May 2021**
Validity of Research Approval:	**08 February 2021– 30 September 2021** **2021/136**
Name of Researcher:	**Montjane VM**
Address of Researcher:	**38 Bafadi Street**
	Norkem Park
Telephone Number:	**065 865 5982 / 076 354 9949**
Email address:	**vmmontjane@gmail.com**
Research Topic:	**Mapping Multimodal Affordances of thr interactive Whiteboards into teaching of Grade 11 Mathematics content : A case study of five Gauteng Township Secondary Schools**
Type of qualification	**PhD**
Number and type of schools:	**5 Secondary Schools**
District/s/HO	**Ekurhuleni North**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

18/05/2021

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. ***Because of COVID 19 pandemic researchers can ONLY collect data online, telephonically or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate. The approval letter will then indicate the type of arrangements that have been made with the school.***
4. ***The Researchers are advised to make arrangements with the schools via Fax, email or telephonically with the Principal.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
6. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
7. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

....

Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 18/05/2021

2

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Annexure C

Letter to School Principal

DATE: 16 August 2021

Dear Principal

My name is Vincent Mahlaseletse Montjane, I am a PhD Student in the School of Education at the University of the Witwatersrand.

I am doing research on how teachers' preparedness and attitudes affect the effectiveness of using the multimodal affordances of the Interactive Whiteboards (IWBs) into teaching of grade 11 Mathematics content. This is a case study of five Gauteng township secondary schools.

The research involves finding out how grade 11 Mathematics teachers use IWBs to deliver content in the classroom. The research study will use questionnaires and interviews to generate data. Learners will not be answering any questionnaires or interview questions. There will be no classroom observations. The study will be conducted during second and third term (From June until August 2021).

I am inviting your school to participate in this research because it will help Mathematics teachers to establish their preparedness and attitudes when they use IWBs to teach. I chose your school because the Gauteng Department of Education has rolled out the e-Solution project (which includes provisioning of IWBs) and I want to explore how these resources are being used to enhance teaching and learning. Each of the teachers will be served with a letter of information and a consent form to indicate their interest and willingness to participate in the research.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. The participants will not be paid for this study.

The names of the research participants and identity of the school will always be kept confidential throughout the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed five years after completion of the project.

Please let me know if you require any further information. I look forward to your response.

Yours sincerely,

VM Montjane

Vincent Mahlaseletse Montjane

vmmontjane@gmail.com

Annexure D

Letter to School Teachers

DATE: 16 August 2021

Dear Sir / Madam

My name is Vincent Mahlaseletse Montjane, and I am a PhD Student in the School of Education at the University of the Witwatersrand. As part of my research studies, I am investigating how teachers' preparedness and attitudes affect the effectiveness of using the multimodal affordances of the Interactive Whiteboards (IWBs) into teaching of grade 11 Mathematics content. I am conducting this research project under the supervision of Professor Reuben Dlamini in five Gauteng township secondary schools. The aim of this research is to understand teachers' preparedness towards the integration of IWBs as pedagogical tool in teaching grade 11 Mathematics content and establish if there are any relations between teachers' attitudes and the way in which IWBs are integrated.

As part of the project, I would like to invite you to take part in responding to a questionnaire and interview questions. This process will take around 30 minutes. A questionnaire will be made available to you through email and interviews will be conducted online. With your permission, I would also like to audio record the interview using a digital device. This recording will be stored in a password protected computer and only the researcher will have access to this recording. It will be deleted after 5 years upon finishing with the research project.

There will be no personal costs from you if you participate in this project, you will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. The interview will be completely confidential, I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else. You will not be advantaged or disadvantaged in any way. Your participation is voluntary so you can withdraw your permission at any time during this project without any penalty. I will be using a pseudonym (false name) to represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume another time.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report which will be available online through the university library website. The data collected from this research project will be stored in a password protected computer and will be kept for five years. With your permission, the data collected from this research project may be used by other researchers in an anonymized format. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Thank you very much.

Yours sincerely,

Vincent Montjane (vmmontjane@gmail.com)

Annexure E

Consent Form for Teachers

Researcher: Vincent Mahlaseletse Montjane

Please indicate your willingness to participant in my voluntary research project called:

Mapping multimodal affordances of the Interactive Whiteboards into teaching of grade 11 Mathematics content: A case study of five Gauteng township secondary schools.

I, _________________________ give my consent for the following:

Permission for questionnaire Circle one

- I agree to fill in a question for this study. YES/NO

Permission to be interviewed

- I would like to be interviewed for this study. YES/NO
- I agree that the interview may be audio recorded. YES/NO
- I know that I can stop the interview at any time and do not have to

answer all the questions asked. YES/NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe. My name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- All the data collected during this study will be destroyed five years after completion of the project.

Sign______________________________ Date____________________________

Annexure F

Questionnaire for Teachers

Section A

General Information

Please tick all boxes applicable to you.

No	Item	Answer	No	Item	Answer
	Basic information			**Teaching experience**	
1	District Name	[ ] EN	6	Teaching experience in the FET phase	[ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 5 – 7 Years [ ] 8 Years +
2.1	Gender	[ ] Male [ ] Female	7	Number of year teaching Mathematics	[ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 5 – 7 Years [ ] 8 Years +
2.2	Age	[ ] Years			
3	Race	[ ] African [ ] White [ ] Coloured [ ] Indian	8	Number of year teaching Mathematics in grade 11	[ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 5 – 7 Years [ ] 8 Years +
4	Subject	[ ] Mathematics [ ] Mathematical Literacy	9	Number of year teaching Mathematics with IWB	[ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 5 – 7 Years [ ] 8 Years +
5	Designation	[ ] Educator [ ] HOD	10	Number of year teaching Mathematics with IWB in grade 11	[ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 5 – 7 Years [ ] 8 Years +

Section B

Access to Interactive Whiteboard

Which of the following do you have access to, for professional use? *Select all applicable*.

No	Access to Interactive Whiteboard (For professional use)	Yes (√)	No (√)
1	Access: Do you have access to Interactive Whiteboard?		
2.1	Training: Did you have any Interactive Whiteboard training?		
2.2	Technical and Pedagogical Skills How have you acquired IWB skills? Choose the suitable answer below: 1. Formal training 2. Non-formal training 3. Personal experience "trial and error" 4. User Manual 5. Referral/ Social interaction		
3.1	Technical and Pedagogical Skills: Are your skills of using IWB to teach Basic, Average, or Advance?		
3.2	Do you have access to the IWB's interactive contents, shapes, 2D & 3D content, diagrams, and videos?		
3.3	Are you able to access Mathematics eBooks/ e-content/ multimedia loaded on the IWB?		
4	Do you have access to other educational programmes or software installed on the IWB?		
5	Does the IWB have any reliable internet connection access (Local Area Network, Wi-Fi, 3G or Wire Connection)?		
6	Are you able to link the Interactive White Board with other ICT devices such as laptop or tablets?		
7	Are you able to send or receive any Mathematics content (notes, class activities, assignments, etc) to learners through IWB?		
8	Are you able to set up activities on the IWB which will continue engaging learners outside the classroom?		

Section C

Navigating and preparing Mathematics content on the Interactive Whiteboard

Please indicate your experience by selecting what is appropriate to you.

No	Skills	No experience	Has experience
1	Use Interactive Whiteboard software to teach Mathematics.		
2	Group and move shapes/objects according to lesson specific outcome.		
3	Use the Gallery/tools (search, insert clip art and interactive games in the gallery) to enhance your teaching.		
4	Use tools and Mathematics content to suite your teaching style.		
5	Use multimedia content to teach.		
6	Create animations using object properties to improve information presentation.		
7	Link web pages and pages in the Interactive White Board to expand Mathematics content exposure.		
8	Use interactive tools to develop Mathematics interactive lessons.		
9	Use Interactive tools to promote active participation.		
10	Use tools and Mathematics content to promote communication.		
11	Use tools and Mathematics content that promote collaboration.		

Section D

Usage of Interactive Whiteboard for teaching of Mathematics.

Please select what is applicable to you and give responses for 6.2, 7.2 & 8.2.

No	Criteria	Disagree	Neutral	Agree
1.1	I find teaching with IWB helpful.			
1.2	IWB is a reliable tool for teaching.			
2.1	I find teaching with IWB easy.			
2.2	IWB helps present subject content much simpler.			
3.	IWB is a reliable tool that enhances teaching in the classroom.			
4.	Through the IWB's multimodality, lesson objectives are always achieved.			
5.	IWB helps in creating new learning experiences.			
6.1	My teaching becomes effective when using IWB.			
6.2	How is the IWB, helping you to teach effectively?			
7.1	I become productive when teaching with IWB.			
7.2	How is the IWB helping you to become productive?			
8.1	IWB helps to improve learner attention.			
8.2	How is the IWB helping you to improve learner attention?			

Annexure G

Interview questions for educators

1. My teaching becomes effective when using IWB in Mathematics lessons.

   Yes or No

2. How is the IWB helping you to teach Mathematics effectively?

____

____

3. I become productive when teaching Mathematics with IWB.

   Yes or No

4. How is the IWB helping you to become productive when teaching Mathematics?

____

____

5. IWB helps to improve learner attention during Mathematics lessons.

   Yes or No

6. How is the IWB helping you to improve learner attention during Mathematics lessons?

____

____

7. How many hours do you use the IWB to teach Mathematics content per week?
   a. 0 – 1hr:30min
   b. 1hr:30 – 3hrs
   c. 3hrs – 4hrs:30min
   d. 4hrs:30min – 6hrs
   e. Above 6hrs
8. Do you find teaching with IWB enhancing learning in Mathematics classroom?
   a. Yes
   b. No
   c. Maybe

If yes, how?

____

____

9. Has the use of IWB affected your teaching strategy?
   a. Yes
   b. No
   c. Maybe

If yes, how?

____

____

10. How have you used the IWB to improve knowledge retention during Mathematics lessons?

____

____

11. How have you used the IWB to promote learner-centred approach and interaction during Mathematics lessons?

____

____

12. In what way has the IWB helped you accommodate diverse learning experiences during Mathematics lessons?

____

____

13. How have you used the IWB to elevate learners’ understanding from known to unknown?

____

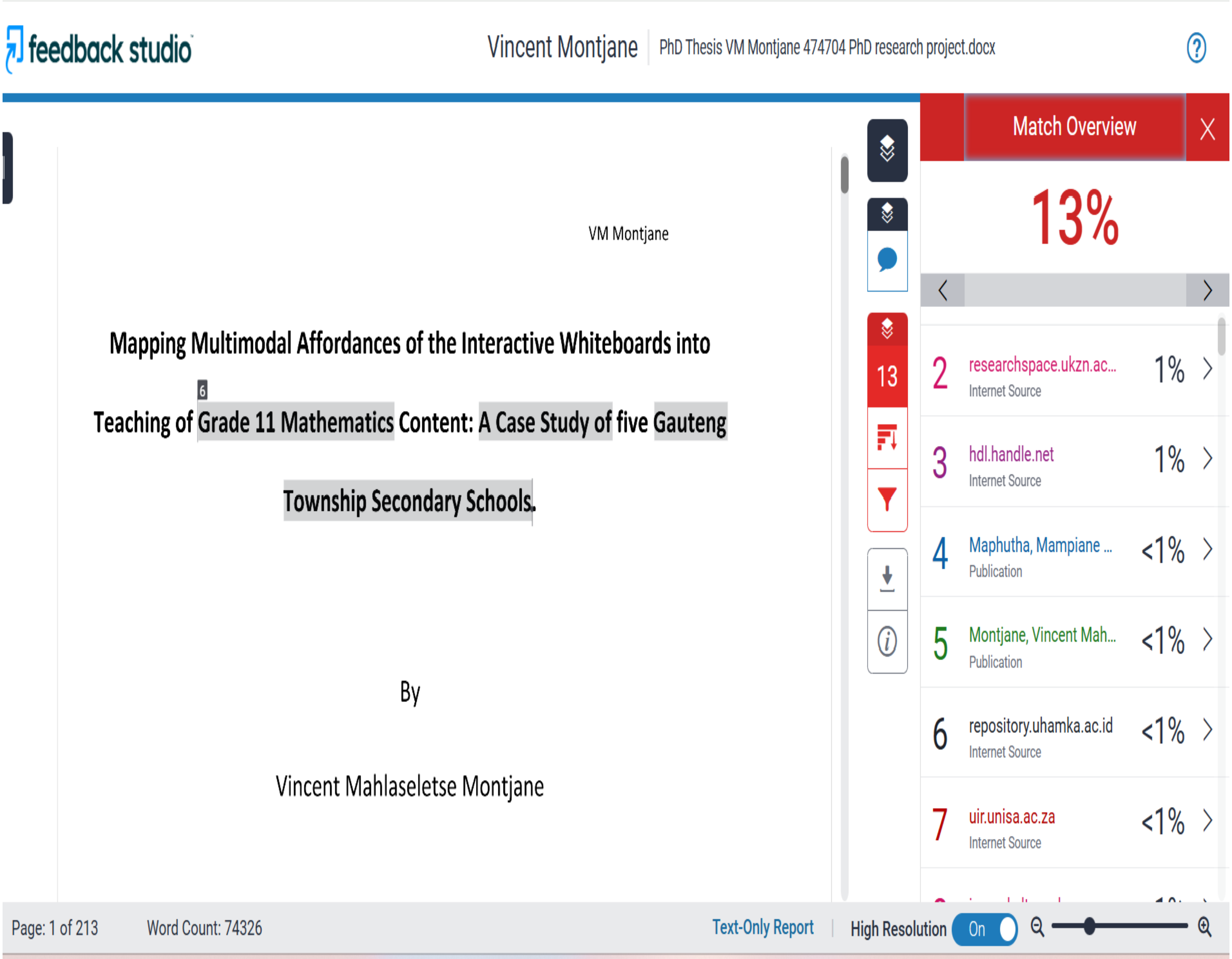
____

14. How have you used the IWB to improve learner participation and promote collaboration during Mathematics lessons?

____

____

Annexure H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Annexure I

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TO WHOM IT MAY CONCERN

This letter serves to confirm that I have edited and proofread the manuscript with the title: **Mapping Multimodal Affordances of the Interactive Whiteboards into Teaching of Grade 11 Mathematics Content: A Case Study of five Gauteng Township Secondary Schools** for grammar, punctuation, spelling, overall style and logical flow. The edits were carried using the 'track changes' feature in MS Word, giving the author the final decision to accept or reject the changes, comments and suggestions prior to submission. Please note that I have not altered the author's intentions or research content drafted by the author.

I am an English Language Practitioner and a professional editor with academic writing and editing skills. Should you have any questions or concerns, please contact Mohoebi Editing Services at mohoebi@gmail.com.

Yours Faithfully,

MAMohoebi

Matseliso Alice Mohoebi (Ph.D)