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Research Topic: **Investigating the Pedagogical Practices of Grade 11 Mathematics Teachers on the Usage of Interactive White Boards: A Case study of Two Gauteng Township Secondary Schools.**

Research Question: **How do the pedagogical affordances of IWBs support learner-content, learner-teacher and learner-learner interactions in the teaching of Mathematics in Grade 11?**

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ABSTRACT

This research study is an investigation of the extent to which Interactive White Boards (IWBs) are pedagogically integrated in the classroom, and how they influence the pedagogic practices of teaching Mathematics. The use of IWB in education has transformed the culture of teaching and learning in the education system. However, the existence of IWB in the classroom has brought affordances and limitation, which affects the pedagogic practices of teachers daily.

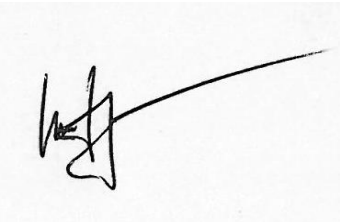
This case study has zoomed in to the Interaction Equivalency Theorem (Anderson, 2003) in trying to understand how IWB supports the three types of interaction: learner-content, learner-teacher, and learner-learner. It is framed within the social structuralism and constructivist approach. The study sees learning as socially and actively constructed phenomenon and IWB as mediating artefacts in learning.

The study was conducted in two Gauteng Province public secondary schools. Through questionnaires, interviews and observations data was generated from the participants. A qualitative approach was used to present, interpret and analyse data. The findings of the study indicated that the pedagogical affordances of IWBs has positively influenced the way Mathematics content is delivered, and has also given teachers pedagogic opportunities that support **l**earner-content, learner-teacher and learner-learner interactions in the classroom.

DECLARATION

I, Vincent Mahlaseletse Montjane, hereby declare that this research report is my own work and unaided work. All resources that have been used, they have been acknowledged. This research study has not been submitted before for any degree or examination at any institution. It is submitted to fulfil the requirements of the Master of Education in the University of Witwatersrand, Johannesburg.

Vincent Mahlaseletse Montjane



Date: 15/ 02 / 2018

DEDICATION

I dedicate this research report to my parents, Abram Mashikane Montjane and Maggie Mahlasele Montjane. You have always been there for me when I needed you most. Your love and support cannot be compared to anything.

ACRONYMS

DoE	Department of Basic Education
FET	Further Education and Training
ICT	Information and Communication Technologies
IWB	Interactive White Board
GDE	Gauteng Department of Education
GoL	Gauteng online
HOD	Head of Department
NCS	National Curriculum Statement
SMT	School Management Team
SSIP	Secondary School Improvement Plan
ZPD	Zone of Proximal Development

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Chapter 1

1.1 Background of the study

1.1.1 Introduction:

The South African Education system has an obligation to deliver quality education to enable the society to deal with ever changing social and economic trends. The education system should ensure that it delivers quality education that will make citizens become more accountable and equipped with high order skills to be able to solve problems. However, the education system faces a challenge in making sure that the new National Curriculum Statement (NCS) is correctly implemented in order to ensure that there is effective teaching that improves quality of learning experience in schools (Bagarukayo & Kalema, 2015). The NCS which operates on the principles of Outcomes Based Education (OBE) aims at empowering learners with skills and knowledge that can be used in an industrial (or global) world. The teaching and learning approach within the NCS encourages an active and learner approach (Bagarukayo & Kalema, 2015). These skills and knowledge are surely not going to be achieved through tradition teaching methods that only encourage teacher dominance and retention of knowledge by learners. A new approach that entails "hands-on learning activities, such as solving real world problems" is most likely to improve learners' skills and knowledge (De Witte & Van Klaveren, 2014, p. 6).

Adoption and usage of Interactive White Board (IWB) by teachers progresses through different stages. For Beauchamp (2004), usage of IWB rages from, a black/whiteboard substitute; apprentice user; initiate user; advanced user; and synergistic user. Teachers initially use the IWB as a black/whiteboard substitute, where with time, they eventually become synergistic user. Teachers and learners who are at the synergistic level are highly competent and innovative users. Moving from Beauchamp's (2004) use of the IWB model by teachers, Beauchamp and Kennewell (2010) developed an ICT interactivity model between teacher and student. The model suggests five levels of ICT interactivity, summarised as follows: no

interactivity; authoritative interactivity; dialectic interactivity; dialogic interactivity; and synergistic interactivity. Vissa (2016) insists that teachers ought to strive to reach the synergistic interactivity level in order to ensure that learners develop higher-order thinking and good communication skills. The no interactivity level is experienced when IWB are used as black/white board where content is delivered passively without any interactivity (Vissa, 2016). While synergistic interactivity is experienced when teacher and learners are actively and meaningfully engaged, they are using the IWB to innovatively learn and interact with content knowledge (Vissa, 2016).

Based on Beauchamp and Kennewell (2010), interactivity happens in various forms and may either be technical, physical, or conceptual in nature. Technical interactivity has rapid and dynamic feedback and response functions of the IWB, such as drag-and-drop, and hide-and-reveal (Beauchamp & Kennewell, 2010). On the other hand, the physical manipulation on the IWB best describes the physical interactivity of the IWB. Conceptual interactivity on the other hand actively engages both learners and teachers in generating and evaluating ideas in order to construct new knowledge (Beauchamp & Kennewell, 2012). The three forms of interactivity can only be experienced once learners and teachers have access to Information and Communication Technologies (ICTs).

Access to ICT resources is one of the challenges South African schools are experiencing. Most South African public schools do not have access to ICTs, and even if they have access, some schools still find it difficult to integrate ICTs into the school curriculum. This ultimately results in ICT resources such as IWB, computers and projectors being either poorly or underutilised in schools. The integration of these ICT resources into teaching and learning in one way or another affects teachers' method of teaching. ICT resources can help address educational problems only if they are appropriately used (Roblyer & Doering, 2012).

In order to narrow the access gap, the Gauteng Department of Education has equipped Grade 11 classroom with IWBs in most non-fee paying township schools in 2016. The non-fee paying schools are categorised under Quintile One to Three. These are schools located in the previously disadvantaged areas, such as townships and squatter camps. The provision of these

ICT resources has triggered debates around the education system and some professionals regard this initiative as a wasteful expenditure. Some education officials regard IWB as modern projectors, while others regard them as interactive tools that enable teachers to manipulate information to suit their teaching methods. This has necessitated this research study, which investigates the pedagogical practices of Grade 11 Mathematics teachers on the usage of IWBs

1.1.2 Aim of the Study

The aim of the study is to ascertain the extent to which IWBs are pedagogically integrated in the classroom, and to determine the way in which they influence the pedagogic practices of teaching Mathematics in Grade 11. In addition, through the Interaction Equivalency Theorem (Anderson, 2003) lens, the research would contribute to the understanding of how IWB supports the three types of interactions, namely: learner-content, learner-teacher, and learner-learner.

1.1.3 Research Objectives

The objectives of this research study are:

1. To determine the extent to which the pedagogical affordances of IWBs support learner-content, learner-teacher, and learner-learner interaction in the classroom.
2. To investigate how the usage of IWBs influences the way Maths teachers deliver Maths content in the classroom.
3. To understand how the pedagogical affordances of IWBs expand Maths teachers pedagogic techniques.

1.1.4 Research Topic

Investigating the pedagogical practices of Grade 11 Mathematics teachers on the usage of IWBs: A case study of two Gauteng township secondary schools.

1.1.5 Research Question

How do the pedagogical affordances of IWBs support learners-content, learners-teacher and learner-learner interactions in the teaching of Mathematics in Grade 11?

1.1.6 Critical Questions

The study aims to answer the following three critical questions:

1. To what extent does the pedagogical affordance of IWBs support interactivity in the classroom?
2. How does the usage of IWBs influence the way Maths teachers deliver Maths content in the classroom?
3. How do IWB's pedagogical affordances expand Maths teachers' pedagogic techniques?

1.1.7 Significance of the Study

The purpose of this study is to investigate the extent to which pedagogical affordances of IWB support interaction in the classroom. Provisioning of IWBs is steadily growing in Gauteng province. However, these tools are underutilisation in some schools. This is due to poor systematic approaches to the provisioning and management of these tools. Amongst other challenges that teachers are facing is the inability to develop a pedagogical approach that suites the IWB classroom. Usage of IWBs is threatened by teachers' poor ICT skills and knowledge about IWB's pedagogic opportunities. Teachers have been left with no choice but to develop teaching approaches for IWB classrooms without guidance. Glover and Miller (2001), suggest that such teachers find it difficult to use a pedagogical approach and IWB's interactivity to impact on teaching and learning. The inability to fully utilize the IWB as pedagogic tools that enhance teaching and learning leads to classrooms with clashing pedagogic practices (Glover & Miller (2001). The study aims to explore the practices of Maths teachers when using IWB to deliver the lessons.

The pedagogic affordances of IWB has turned Maths classroom into active learning space, collaborative environment and information hub centre in schools (Kennewell & Morgan, 2003). Such classrooms exist by modelling the pedagogic approaches to suite the IWB enabled classrooms. The presence of IWBs has unsettled Maths teachers' teaching approach, teachers are forced to review their traditional teaching approach. Teachers are challenged to adapt a new teaching approach which incorporate the use of IWB. The study further aims to investigate how the usage of IWB influences the way Maths teachers deliver Maths content in the classroom.

1.1.8 Problem Statement

Social inequalities brought by the apartheid government, necessitated the Department of Basic Education (DoE) to formulate a White Paper on e-Education (2004) which was supposed to serve as a roadmap to unlock ICT integration in schools. Gutterman, Rahman, Supelano, Thies & Yang, (2009) pointed out that ICT can play a very significant role in aggregating the right access to and to providing better quality education for teaching and learning. White Paper on e-Education stresses the importance of having access to ICT resources. As much as access to ICTs cannot be seen as a silver bullet for all ICT challenges, it can serve as a stepping stone towards transforming teaching in the classroom.

Light (2001, p. 723) sees access to ICTs as a significant aspect in education, as well as a means of bridging the digital divide. Technological determinists forward a similar claim, believing that "closing the gaps in access to computers will mitigate broader inequalities" (Light, 2001, p. 723). Based on the White Paper on e-education "the impact and effectiveness of ICTs rest on the extent to which end-users (learners, teachers, managers and administrators) have access to hardware, software and connectivity. For e-Learning to be successful, learners must have regular access to reliable infrastructure" (p. 23). It is for this reason that the White Paper on e-Education insist that "every learner in the general and further education and training bands will be ICT capable by 2013"(p. 23).

The Gauteng Department of Education (GDE) tried to align itself to the Department of Basic Education (DoE)'s White Paper on e-Education (2004), by developing strategies that intended to

solve the existing imbalances in Gauteng schools. The Gauteng online programme was introduced in 2002 as a means of closing the access gap of computers to most public schools. The Gauteng online laboratories (GoL) were built, with twenty five (25) computers, in most public schools. The introduction of Gauteng Online labs was to ensure that Gauteng schools have connectivity, access to internet and computers to support the integration of ICTs. Former Education Minister supported the GoL initiative, and she encouraged teachers to make sure that no learner ought to leave school without being ICT literate. The challenge was that the twenty five (25) computers were insufficient, as the average classes in public schools range around forty (40) learners. As a result, some of the learners were forced to share computers. The other challenge of Gauteng online was that, faulty computers were left unattended for a long time. This left schools with resources that were not functional. Some schools spent months without internet connectivity, where even if Gauteng online officials were aware, it took them time to address the problem.

The Gauteng Online programme could not live up to the expectation, where it failed due to insufficient computers, lack of computer support and maintenance, poor internet connectivity and teachers lacking ICT skills. And the digital divide amongst Gauteng public schools could not be narrowed. Bialobrzeska and Cohen (2003), regard the process of narrowing the digital divide as a means of providing ICT resources to those who do not have them, and providing skills to those who have access to these resources. GDE was left with no choice but to review its strategies towards closing the digital gap by introducing strategic drivers as listed below:

- Pillar 1: Curriculum and Assessment Development;
- Pillar 2: Teacher Provision and Support;
- Pillar 3: Leadership and Management;
- Pillar 4: Infrastructure Development and maintenance;
- Pillar 5: Planning, finance and resourcing;
- Pillar 6: ICT in Education;
- Pillar 7: Social Cohesion;
- Pillar 8: School functionality including community involvement;
- Pillar 9: Skills Development; and

- Pillar 10: Access to quality Early Child Development (ECD)

The ten pillars serve as strategic drivers for educational transformation which seeks to narrow ICT access, integration and the ICT skills gap. Of importance to this study is pillar number six (6) which was introduced to address the following:

1. connectivity – All schools have connectivity through State Infrastructure at the classroom level – all learners in the classroom have access to connectivity.
2. e-Learning Solution – create a hub of information in the form of;
    a) content knowledge to assist teachers in curriculum delivery; and
    b) learner access to learning material, workbooks and other subject matter;
3. ICT infrastructure and equipment to schools, namely iPads/ tablets/ desktops that will be utilised by learners in the classroom;
4. support of equipment/procurement will be done by a centralised procurement agency to ensure the smooth and efficient process of support to schools; and
5. teacher development in the ICT sphere – training of educators in the use of the equipment.

In order to implement Pillar Number 6, the Gauteng Department of Education commenced the provision of IWBs in most township secondary schools. The project prioritised only five (5) township secondary schools in Gauteng for the academic year 2014. Only Grade 12 teachers and learners benefitted from this initiative in 2014. The following year the project was rolled out in Grade 12 classrooms for all non-fee paying township secondary schools. As the programme expanded, Grade 11 classrooms were equipped with IWBs in 2016. Currently only Grade 11 and 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 which will foster active learning.

The Mathematics pass rate in the Further Education and Training (FET) band has been below 90% for past four years as per the 2015 National Senior Certificate Technical report. The report shows that learner performance in Mathematics is low as compared to other subjects. The report shows various intervention strategies such as Secondary School Improvement Plan (SSIP)

that the Nation Department has adopted to improve priority subjects. Even after many strategies have been developed and implemented, the 100% achievement in Mathematics seems to be a bridge too far. One of the contributing factors of poor learner performance in Grade 11 and 12 Mathematics is that teachers find it hard to teach mathematical concepts in a more practical and meaningful manner. The chalkboard that was long used could not give teachers sufficiently interactive ballast. Moreover, the chalkboard could not provide sound and visual features to support teaching and learning. This has left teachers with no choice but to continue teaching Mathematics in a less practical and overly abstract manner. The newly provision of IWBs in Grade 11 classrooms, coupled with the poor performance in Mathematics has prompted this study, which is designed to establish whether the pedagogical affordances of IWBs will support interaction and also give teachers pedagogic affordances to enhance teaching and learning.

Chapter 2

2.1 Literature review

This section will first discuss how the term affordance was conceptualised and followed by a brief over view of IWB affordances and constraits. Literature that support pedagogic affordances and importance of using IWB in the classroom will be discussed. More emphasis will be placed on literature that explains how IWB enables interaction in the classroom. A discussion will be conducted in relation to the classroom context.

2.1.1 Digital pedagogies and ICT Affordances

McLoughlin and Lee (2007), define the term affordance as "the activities or practices that the function of a technology enables the user to perform". Other theorist such as Hammond (2010), regard affordance as "a relationship between an organism and an object with the object perceived in relation to the needs of the organism" (Hammond, 2010, p. 206). From Gibson's perception, the opportunities that an object (Interactive White Board) possesses differ according to the need but its properties will always remain the same. A tree is cited as an example of an object that has unchanged properties, but that gives different opportunities to different species, such as serving as a shelter during rainy days, or being used to hide from a pursuer (Hammond, 2010, p. 206).

According to Gibson, affordance has always existed, "but it needs to be perceived to be realised" (Hammond, 2010, p. 206). For Gibson, the unchanged nature of the environment offers a range of opportunities for action, but also offers countless constraints on action (Hammond, 2010, p. 206). Gibson further defines affordances as "actionable properties that existed between the world and the actor" (John & Sutherland, 2005, p. 407). John and Sutherland (2005) took the explanation of affordance further, highlighting that "the key link between the object and the individual is direct perception, which Gibson claimed is mediated by the level of mediums, surfaces and substances" where this "level of perception then informs

individual affordances, and action transforms these into affectivities which extend human capabilities" (p. 407).

For Norman (1998) (cited in Hammond, 2010, p. 208) the term affordance refers to the "perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used". From Norman's theory of affordance, he highlights three important concepts which include: "how the environment could be both symbolically and physically designed perception of the user (rather than the invariant properties of the tool) and how goals, culture and past experience influence perception" (Hammond, 2010, p. 208). Norman's theory of affordance is more interested in the role of culture and context as compared to Gibson's theory, which is based on the direct perceptual pick up of an affordance. Gibson sees affordances as directly perceived, while Norman's affordance theory is based on culturally mediated perception. Norman's theory of affordance presents itself as the most adequate theory, because it emphasises that a person's perception is based on the social and context of the environment. Perceptions are not all about what we pick up from the environment (physical properties), but they are influenced by our culture and the context of our environment.

Based on Conole and Dyke's (2004) theory of affordances, ICTs have general affordances, which are relevant to teaching and learning. However, ICTs have limitations, which are called constraints. These ICT contraints are contextual and have chances of influncing teaching and learning negatively. This calls for technology users to familirise themselves with affordances and constraints of ICTs in order to improve their classroom practice. Kivunja (2013), suggests that there are teachers who need to be reskilled so that they will start appreciating "the role of technology in the teaching of pedagogy and content knowledge" (p. 131). The reskilling of these teachers helps to elevate their digital competencies and improve pedagogical practices.

Education has slowly become inseparable from digital technologies. A new teaching approach called digital pedagogy has emerged from these modern digital technologies. Howell (2012), values the importance of digital pedagogies and he defines them as a practice of investigating how teaching with digital technology ought to be structured. Teachers have started using digital pedagogies to address the demands and competencies of the knowledge society (Clarke &

Clarke, 2009). Their classroom practice is improved by aligning the technology with accurate pedagogic approach. Moreover, instilling the value of digital pedagogy to teachers is very key, because it advantages them to see the importance of technology and the teaching approach of pedagogy (Clarke & Clarke, 2009). The digital pedagogy influences how teachers administer lessons in their classroom, their role is expected to change since learning becomes social and interactive.

2.1.2 Affordances and Constraits of IWB

The IWB afford teachers to use several of the same programmes to explain concepts, and learners find the IWB more motivational, fun, and make learning to be more interesting (Wall, Higgins & Smith, 2005). Learners find joy when they manipulate pictures and objects on the IWB. Wall, Higgins and Smith (2005) insist that IWB brings an element of reality to the classroom, due to the demonstration capacity they introduce. Learners are able to construct meaningful knowledge as they are presented with concepts from various perspectives. Specifically, the IWB encourages the kinaesthetic approach that allows learners to physically interact with objects on the boards rather than listening to a lecture or observing an experiment (Wall, Higgins & Smith, 2005).

The technical reliability of the IWB is questionable when it comes to teaching and learning in the classroom. One of the IWB constraints is the tendency of freezing or rebooting of the board in the middle of the lesson (Wall, Higgins & Smith, 2005). This requires users to calibrate the board during the lesson, where more teaching time is compromised during this process. Teachers' lack of technical knowledge influences the way lessons are delivered during the lesson. The inability of teachers to manipulate information in an innovative way on the board influences the lesson in a negative manner, because teachers spend more time trying to navigate through the board (Wall, Higgins & Smith, 2005). The difficulty teachers face in using the IWB leads to poor representation of subject content, and inappropriate pedagogical teaching approach (Angeli & Valanides, 2009). These difficulties cannot be taken for granted, because teachers' skills coupled with the appropriate IWB affordances have high potential to

transform subject content which when clearly presented may widen students' conceptual understanding (Angeli & Valanides, 2009).

Researchers have cautioned IWB users not to become carried away and think that IWB will automatically mediate learning. Tanner, Jones, Kennewell and Beauchamp (2005) hold the perspective that, the level of interaction when IWB is used in the classroom is dependent teacher's ability to use the board, and mediate the affordances and constraints within the learning environment. Not all IWB programmes will facilitate interactivity in the classroom. An example can be drawn from the use of PowerPoint programme, which is known to be teacher centred and restricting interactivity. However, the nature of IWB has socially been known to support and encourage the high accessibility of information, communication and collaboration (Tanner et al., 2005).

Below is a summary of ICT general affordances/ constraints and their description.

Table 1: *The general affordances and constrains of ICTs.*

Affordance/ Constraint	**Description**
Accessibility	ICTs provide "easy access to vast amounts of information"
Speed of change	"Immediacy of access to rapidly changing information"
Diversity	"Access to a vast range of diverse and different experiences"
Communication and collaboration	"Offers the potential for learning enriched by engagement with the 'other'" as well as the development of new communities
Reflection	"ICT has the potential to enable reflection and criticality to be enhanced"
Multimodal and non-linear	"Leads to the potential for different routes through, and forms of, learning"
Risk, fragility and uncertainty	ICTs can lead to unintended consequences in learning like plagiarism. (this is more of a constraint)
Immediacy	The speed of information raises response times.
Monopolization	"Tension between the benefits of diversification and sharing of developments"
Surveillance	"Those with power can extend their gaze and secure greater knowledge and control over others"
Content creation[1]	"Web 2.0 emphasises the pre-eminence of content creation over content consumption. Anyone can create, assemble, organize and share content to meet their own needs and the needs of others"
Knowledge and information aggregation and content modification	Large amounts of knowledge and information can be brought together and syndicated

2.1.3 **Pedagogic Affordances**

Studies have found that IWB have pedagogically helped teachers to scaffold learners through mediated activities. Learner participation in IWB classes was seen to be improving, due to teacher intervention in group activities (Warwick & Mercer, 2011, p. 6). When IWB are used for exposition and development the learning context changes to a more focused form of learning, which can be "classified in three ways: intrinsic stimulation provided by the combination of the visual, kinaesthetic and auditory paths to learning; second the sustained focus maintained throughout the lesson by the teacher's management and 'orchestration' skills; and third stepped learning through constant challenges with frequent assessment of achievement as a stimulant to further involvement" (Miller, Glover & Averis, 2005, p. 5).

Researchers have also recommended that teachers ought to construct tasks on the IWB which direct, and assist learners to analyse, and interpret tasks of high level order (Warwick & Mercer, 2011). Many researchers have proven that, investing in ICTs such as IWBs hold greater benefits to that of chalkboards. In recent years, schools in the west such as those in England and Wales have invested in IWB technology. The introduction of IWB in the classroom has necessitated researchers to evaluate how pedagogic practices of teachers are influenced by the IWB. Today's learners have ICT skills acquired socially and these skills have a huge impact on how they learn. Research findings have shown that the interactivity of IWB has afforded learners an opportunity to collaborate and actively participate in the classroom (Theodoulou, Avraamidou & Vrasidas, 2015). Studies have also shown that the affordances of IWB enables learners to process information in a creative, relaxed and effortless manner (Theodoulou et al., 2015). The creative and constructive processing of information is also known to be directly linked to the positive learner achievement or performance. The affordances of IWB has been proven to offer "the opportunity for pupils to be allowed to explore their own ideas and share them with the class in a reflective discourse" and these affordances are "mediated by teachers" (Tanner, Jones, Kennewell & Beauchamp, 2005, p. 726).

IWBs are one of the cognitive tools currently used in schools. Based on John and Sutherland's (2005) theory, ICTs are cultural artefacts which come in many forms, such as software and

hardware, and they influence our interaction with the world. John and Sutherland (2005) believe that "in order to understand the development and consequences of" pedagogic opportunities of ICTs such as IWB, teachers need to "interpret the tool itself (its material and structural elements) more in terms of the assumptions it makes about the user, the activities it encourages, and the way it constrains and enables particular activities" (p. 409). Teachers need to familiarise themselves with ICT tools in order to correctly integrate them in their teaching. When teachers are familiar with these tools, they can easily apply relevant teaching method which suites the learning context. This suggests that teachers who excel in ICT integration have necessary content knowledge, good pedagogy and are able to select relevant technology that correctly suites the teaching and learning space. The interactivity of IWB is capable of developing learners to be critical thinkers, because they learn from observation and questioning of their own knowledge.

2.1.4 Importance of Using IWBs

The section below discusses the physical and the technical interactivity**.**

Interactivity is defined as "the function of ICT which enables rapid and dynamic feedback and response" (DfEE, 1998, p. 11). For Beachamp and Kennelwell (2010); Tanner; Jones; Kennewell and Beauchamp (2005) (cited in Vissa, 2016), the interactivity of IWB takes various forms, namely: technical, physical, or conceptual. According to these researchers, Beachamp and Kennelwell (2010); Tanner et al. (2005) (cited in Vissa, 2016, p. 22) the technical interactivity "is regarded as the rapid and dynamic feedback and response function of the IWBs", which involves the dragging and dropping, pulling, hiding and revealing of objects and data. Another form of interaction which takes place on the IWB is physical interactivity. Beachamp and Kennelwell (2010) regard physical interactivity as the "actual physical manipulation on the IWB".

Many IWB theorists have shown that these boards are capable of creating conducive teaching and learning environment (Torff & Tirotta, 2010). For Beeland (2002), IWBs allow teachers and students to interact with applications and other electronic content installed on the board. Beeland (2002, p. 1), provides other advantages of IWBs as follows:

- "Large touch sensitivity area for writing and navigation
- Graphics (still and moving Images) that can be manipulated.
- Sound and video feature
- Animations"

Bryant and Hunton (2000, p. 140) highlight that IWBs utilise a synchronous transmission mode which provide a "two-way interaction between the teacher or student and the medium" and this "participation allows a wider range of participation by the student, leading to an increased state of engagement, and an enhanced learning environment". Another advantage of IWB is that it provides the classroom with visuals that promote student's ability to manipulate and organise information appropriately (McKendrick, 1999). Smith and Blankinship (2000) insist that it is through these visuals that learners' thinking can be challenged to high order thinking and their personal learning styles can be met.

Based on Miller, Glover and Averis (2005), IWBs enable users to manipulate objects to acquire interactivity. They have identified six common manipulation features that the IWB can afford the user. Miller, Glover and Averis (2005, p. 107) summarise the features of IWB as follows:

i) **"drag and drop**: classification, processing, comparing items, ordering terms, testing hypotheses etc., often causing another action from software or expecting further action or comments from pupils;
ii) **hide and reveal:** hiding and then opening a response once a pupil had understood an idea thereby allowing ideas to be stepped in a particular way so that conceptual development takes place, and stepping the development of hypotheses;
iii) **colour, shading and highlighting used**: emphasising similarities and differences, enhancing explanations, and allowing reinforcement through greater emphasis;
iv) **matching items**: equivalent fractions, a straight line with its graph and an equation with its solution;
v) **movement or animation:** to demonstrate principles and to illustrate explanations; and
vi) **immediate feedback:** from teacher, pupil or software, often arising as a direct consequence of one of the other five manipulations".

Based on the above features studies have shown the use of IWB in the classroom enables learners to concentrate and fully engaged in learning. Learner participated becomes high and they are likely to interact with their peers and teachers (Thompson & Flecknoe, 2003).

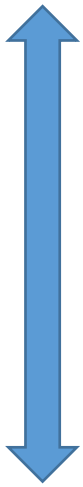
2.1.5 Interaction in the Classroom

The section below discusses the conceptual interactivity.

The conceptual interactivity also known as the dialogue or pedagogical interactivity has high influence on how knowledge is constructed by learners through social interaction with peers and teachers (Beachamp & Kennelwell, 2010). The dialogue interactivity enables learners to be actively involved in their learning environment where their reasoning is challenged as they debate and critically evaluate their thinking.

The higher the degree of teacher control in the classroom, the less interaction will be experienced between learners (McGee, 2003). The conceptual interactivity in class is regulated around teacher and learner control, and the way in which they interact. Moreover, the interaction of learner amongst themselves gradually lessens the scaffolding process from the teacher. Learners become independent and active participants in the classroom. High learner interaction promotes high order thinking and self-driven competency. The 'conceptual' interactivity model is summarised in Table 2 below.

Table 2: *Conceptual Interactivity*

Nature of interaction	Control
Lecture : No interactivity or internal interactivity	High degree of teacher interaction
Low level/ funnelling questioning Rigid scaffolding & surface interactivity	
Probing questioning: looser scaffolding and deeper interactivity	
Focusing or uptake questioning Dynamic scaffolding and deep interactivity	
Collective reflection Reflective scaffolding and full interaction	High degree of pupil interaction

From the constructivist perspective, the use of computers (interactive boards) in teaching and learning promotes interactive learning and improve learner participation in class. Through scaffolding as a mechanism, learners become active learning participants and they regard challenges as opportunities, not threats. The use of ICTs in teaching and learning causes teachers and learners to socially interact with one other and their environment. The social interaction encourages knowledge sharing and it bridges the digital divide that may exist between teachers.

Bakhtin (1981), values meaningful interaction through dialogue in the classroom. For Bakhtin (1981, p. 311), dialogic talk is regarded as a process of creating a space for multiple voices and classroom discourse that challenge power relations constructed by monologic practices. Classroom dialogic allow learners to actively participate during the lesson while they personally

constructing understanding of the curriculum (Bakhtin, 1981). The dialogue concept is supported by Alexander (2006, p. 35) who identifies features of the dialogic classroom as follows:

- "Collective: teachers and children address learning tasks together, whether as a group or a class, rather than in isolation;
- Reciprocal: teachers and children listen to each other, share ideas and consider alternative viewpoints;
- Supportive: children articulate their ideas freely, without fear of embarrassment over 'wrong' answers, and they help each other to reach common understandings;
- Cumulative: teachers and children build on their own and each other's ideas and chain them into coherent lines of thinking and enquiry; and
- Purposeful: teachers plan and facilitate dialogic teaching with particular educational goals in view".

The affordances of IWB has been recommended by many researchers, since it encourages what Alexander (2006) regards as classroom dialogue feature, which influences how learners construct new knowledge and understanding.

From Piaget's point of view, "new understandings are not simply given to children when they learn. Rather children create knowledge when they learn" (Moll 2001, p. 1). Marti (1996), supports Piaget's views since is of the view that newly acquired information on learners undergo an important transformation. IWBs are not designed to provide teachers and learners with information that is not mentally processed. Rather, it promotes active learning that seeks to achieve developed independent expert participants (teachers and learners). The interactivity of the boards provide teachers and learners with scaffolding mechanisms, hence most activities or concepts are built to have practical and kinematic features.

According to constructivist theory, people's actions are mediated by tools and IWBs can be understood as socio-cultural tools that have high influence on teaching and learning (Vygotsky, 1978 & Wertsch, 1991). Based on the socio-cultural theory, "teacher and students bring to the

classroom a history of experiences which relate to their previous cultures of learning and tool use" (Kent & Facer, 2004, p. 447). So when they are faced with a new technology, (such as IWBs) they are likely to use their previous experiences to make sense of the new technologies. This suggests, for example, that many teachers are likely to use digital whiteboards as an extension of the non-digital whiteboard.

Chapter 3

3.1 Theoretical Foundation

The study is framed within the theories of social structuralism and constructivist approach. Vygotsky's theory of social structuralism emphasise that "knowledge is seen as constructed by an individual's interaction with a social milieu in which he or she is situated" (Airasian & Walsh, 1997, p. 445). Fundamental to Vygotsky's theory of social structuralism is the idea of the Zone of Proximal Development (ZPD). For Vygotsky, what "the child is able to do in collaboration today, he will be able to do independently tomorrow" (Blanck, 1990, p. 31). Vygotsky (1978, p. 86) regards the zone of proximal development as the distance between the child's actual development (independent) and the level of potential development (dependant). He suggests that it is in this stage (zone of proximal development), that "learning awakes a variety of internal development processes that are able to operate only when the child is interacting with people in his or her environment and incorporation with his peers. Once these processes are internalized, they become part of the child's independent development achievements" (Vygotsky, 1978, p. 90).

From Vygotsky's point of view, active learning can only be realised if the distance between the learner's actual development and potential development is narrowed. A teacher in a constructivist platform is able to access and work within, what Lev Vygotsky defines it as the Zone of Proximal Development (ZPD), where learners are assisted in order to acquire potential development. The ZPD can be viewed as the metaphorical space whereby "tasks that are too complex to be mastered alone and can be accomplished with guidance and encouragement from a more skilful partner" (Shaffer & Kipp, 2007, p. 278). The teacher helps learners to exceed the boundaries of what they are capable of achieving on their own, and provides new areas for exploration about the subject matter that the learner may not have previously considered on their own.

Drawing from the ZPD theory, Wertsch (1991), regards IWB as a 'mediating artefact' in learning, with features that can act as affordances for learning. It is through these ICT affordances that teachers are able facilitate learning and assist them to reach to their high learning potential.

IWBs were not made to replace a teacher but to enable teachers to innovatively deliver content in more diverse and structured manner. El Rouadi, Al Husni and Al Hassan (2014, p. 81) regard IWB as tools that enable the teacher an interesting teaching "than the traditional common use of other tools". 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 (El Rouadi, Al Husni & Al Hassan, 2014).

Gallimore and Thorp (1990), suggest that "students' exposure to and interaction with others is a critical element of the educational growth" (p. 175). For Gallimore and Thorp (1990), when a computer is to be used to mediate learning, it must not isolate the child from social interactions but rather be used to strengthen social interactions. Moreover, computer based activities are known to mediate learning only if the activities are authentic (Crook, 1994). However, the activities must take into consideration the cultural context of the learner. They should involve communication, collaboration, and interactions with other members of the society (Crook, 1994). This is supported by Woolfolk (2010), in his argument that "computers are more likely to increase achievement if they support the basic processes that lead to learning; active engagement, frequent interaction with feedback, authenticity, and real world connection, and productive group work" (p. 338).

The constructivist approach supports the researcher's view of learning as social and active. According to Allison & Kendrick (2015, p. 113) citing Wadsworth (1996), constructivism "is an epistemological concept based on the idea that learning and the creation of new knowledge is based on, and biased by, an individual's unique experiences and mental schema." Drawing on Vygotsky's theory, the research supports the idea of the interaction that occurs during the use of IWB in the classroom. The multi-modality of the IWB according to Twiner, Coffin, Littleton, & Whitelock (2010) (Cited in Warwick & Mercer, 2011, p. 3), ensures that "teachers and learners have access to text, images, objects, sound and video – increases almost exponentially the potential affordances for learning that this mediating tool can provide". The interaction enables teachers and learners to use the affordances IWB to make teaching and learning more meaningful.

3.2 Theory of Interactivity

Anderson (2003) developed the interactivity equivalency theorem which explains how meaningful learning takes places in the education system. According to the interactivity equivalency theorem, "deep and meaningful formal learning is supported as long as one of the three forms of interaction (student–teacher; student-student; student-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience. High levels of more than one of these three modes will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences" (Anderson, 2003, p. 5). Depending on the nature of the educational instruction, Anderson (2003) insists that interaction mode can be changed without losing educational effectiveness. This implies that the instructional developers have a duty of assess and implement an instructional approach, which suites the learning space.

Interactivity theory resonates with the theory of social structuralism and constructivist approach. Evidence can be drawn from the learner-content, learner-learner, and learner-instructor interaction, which best explains how learners construct knowledge through interacting with the world (Wang, Qiyun, Huay Lit Woo & Jianhua, 2009). From the constructivist perspective, learners don't passively receive information but knowledge is actively constructed. During knowledge construction, learners personally internalise, negotiate, and share information meaningfully (Wang et al., 2009). The theory of interactivity is assumed to enable learners to actively build and modify knowledge, as well as become problem solvers and critical thinkers. The learner interactivity encourages the notion of learning through doing, and hands-on practices (Roussou, 2004).

Interactive teaching has the potential to transform the traditional classroom environment into a more collaborative, effective and innovative learning space. According to Glover and Miller (2001) interactive teaching approach coupled with IWB benefits of IWB encourage learners to compare and contrast knowledge, which is conceptualised through verbal, visual and kinaesthetic stimuli. The IWB enables teachers and learners to interact with subject content in

both audio and visuals forms. Haldane (2007) cautions ICT users about what should be considered when we define how the interactivity of the IWB conceived. Haldane (2007), further explains that interactivity should not be limited to the tool's technical attributes, but should be associated with how teachers leverage the affordance of the tool to improve communication and collaboration. The IWB offers learners kinaesthetic affordances, and they also enhance learner's participation (Glover & Miller, 2005). Moreover, Glover and Miller (2005) insist that interactivity can only be achieved if teachers move from a didactic to the experiential approach in order to maximise adoption of technology in teaching and learning. Interactive teaching encourages proper communication, control and collaboration in the classroom (Soo & Bonk, 1998). The interaction between learner and content (Learner-content) encourages independence, while learner and teacher (Learner-teacher) interaction encourages support and reinforcement of learner's knowledge, and lastly learner-learner interaction encourages collaboration and discovery whilst learning (Soo & Bonk, 1998).

This study utilises pragmatism as an interpretive framework. Creswell (2013) insists that pragmatists "do not see the world as an absolute unity" (p. 29). The researcher has examined what is useful, practical, and what works in the classroom. Due to my ontological beliefs, my interest lies in the way in which IWB enhances the teaching of Mathematics and the role these IWB play in learners engagement with the content and the teacher. The study uses the Learner, Content & ICT resources (IWB) and teacher interaction framework below, derived from Carmean and Haefner (2002) to explain how knowledge is meaningfully constructed.

Figure 1 below summarises the nature of interaction between the learner, teacher and content.

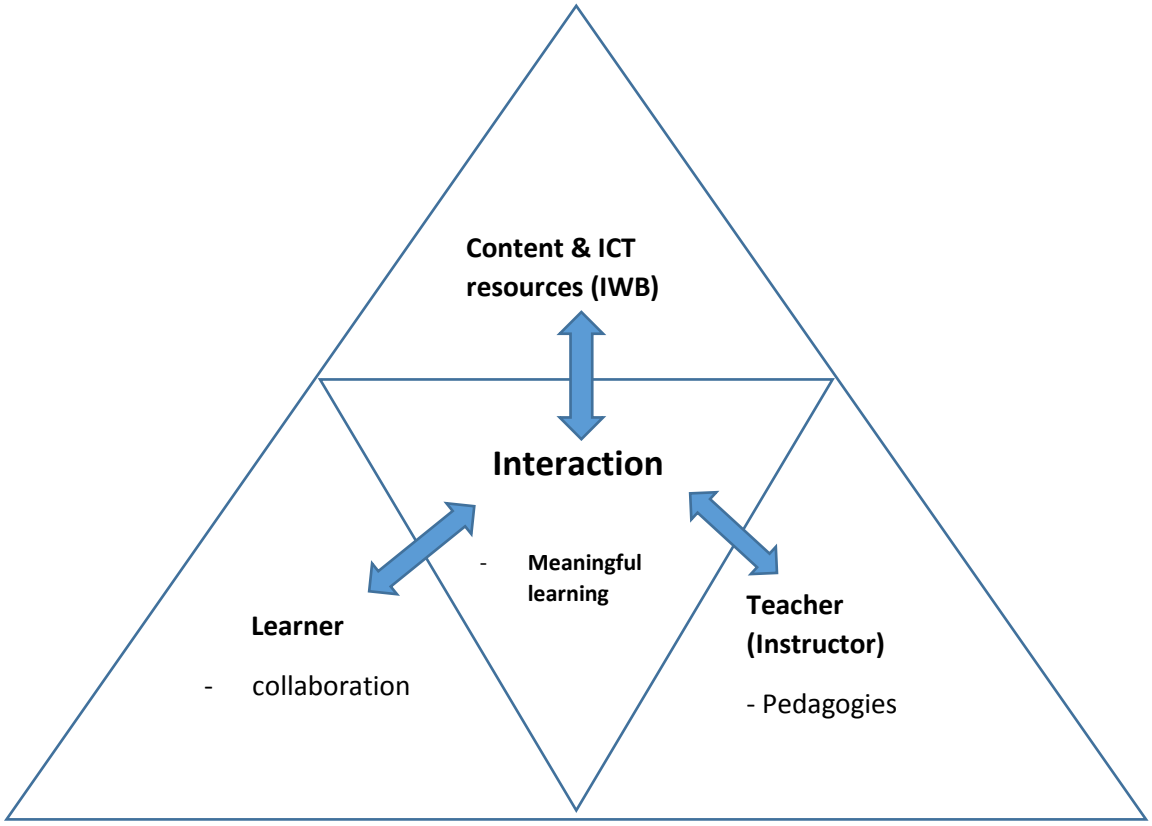


Figure 1*: The nature of interaction between learner, teacher and teacher.*

The theory of interactivity has long been debated in the education cycle. Theorists like Moore (1993), explain interactivity by drawing from pedagogical concepts where learners interact with other leaners (learner-learner), content (learner-content), and instructors (learner-instructor). Learner's content knowledge is clarified and refined as prior knowledge is tested by engaging with subject content, guidance from instructors helps to shape and guide learner understands, whereas knowledge is well constructed when interacting with peers. ICTs such as IWB have a potential in bringing the interaction amongst teachers, learners and the content. These resources offer teachers opportunity to design instructions that are learner-centred (Erbaggio, 2012).

Manny-Ikan (2011) insists that the interactivity of white boards coupled with the pedagogic practices of teachers plays a vital role in a classroom. Similar view was shared by Gillen, Kleine-Staarman, Littleton, Mercer, and Twiner (2007) and Gil-len, Littleton, Twiner, Staarman, and Mercer (2007) (cited in Manny-Ikan, Dagon, Tikochinski & Zorman, 2011, p. 256) that, "while the IWB indicates a pedagogy that is still focused on the teacher, there are a number of clear interactive advantages: the technology allows the teacher to prepare material ahead of time or to be built during the lesson before the class, to retrieve material in an immediate and fast manner to be presented during the lesson as needed, and to change items directly, together with the students during the presentation, so that strategic, multi-faceted instruction can be created". However, Manny-Ikan et al. (2011), continue to caution technology users since "the entry of technology into the classroom is not sufficient to raise the level of interactivity in the class or to adopt a new pedagogy" (p: 256). This calls for technology users to adopt a pedagogy that suite the subject content and classroom context. For Moss, Jewitt, Levacic, Armstrong, Cardini, and Castle (2007), IWBs afford learners an opportunity to develop a structured and systematic content. However, the presence of IWB in the classroom does not guarantee quality learning since a teacher is still required to mediate learning. It is for this reason that Le Breuilly (2004) (cited in Manny-Ikan et al., 2011), insists that "the interactivity in instruction in a smart classroom remains within the framework of the "electronic magic" of the board" and "the modern technology of the board allows the students and teachers to have a reciprocal and interactive relationship with the board" (p. 256).

The interactivity of the IWB is framed around the nature of interaction and the teacher control. Armstrong, Barnes, Sutherland, Curran, Mills and Thompson (2005) regard the IWBs as an ICT tool that has a potential in affording interaction "if the teacher perceives that it can be used in this way, and uses appropriate software that also affords interaction. The IWB may not afford interaction if it is perceived as a presentational tool only. Interaction can, of course, mean many different things. Our use of the term interaction foregrounds the give and take between pupils and teachers, which goes beyond a superficial learning scenario to a stimulating interplay which leads to new formulations and new understanding" (p. 457).

The nature of the IWBs may afford teachers to simply use either keyboard or pens to manipulate information. This means that teachers can make use of IWB differently to

manipulate information in a meaningful way (Amstrong et al., 2005). For Glover and Miller (2001), IWBs are "least effective and have limited impact on teaching and learning when teachers 'fail to appreciate that interactivity requires a new approach to pedagogy' and there may be a tendency for IWBs to be used more as an interest enhancer than as a new approach to learning" (p. 269).

There are debates as to whether the use of IWB brings change to the pedagogical practices of educators. As per the report by BECTA (2008) (cited in Manny-Ikhan et al., 2011) no evidence was found "of pedagogical change among teachers who used IWBs" and other studies also "showed that the use of the boards improved teachers' confidence, particularly in using technological skills" not the pedagogical practices (p. 253). Moreover, Lewis (2003) insists that IWB cannot solve pedagogical problems since they bring technical opportunities which contribute less to the teaching and learning method. Manny-Ikhan et al., (2011) however, give another version of the way in which IWBs bring about change of pedagogical practice in the classroom. They cites Bennet & Lockyer (2008); Lee & Boyle (2004); Levy (2002) and Solvie (2004), as they explain that "the use of the IWB allows teachers to prepare comprehensible lesson plans with a variety of creative options, thus contributing to the enjoyment from instruction and to meaningful changes from the traditional instructional methods" (p. 254).

From the evidence gathered by Gillen, Staarman, Littleton, Mercer, and Twiner (2007) (cited in Manny-Ikhan et al., 2011), they found that "the IWB can serve as an effective tool to encourage interaction between the students and the learning material, using teaching methods that include presentation of material in various ways" (p256). Based on whether IWB brings change to the pedagogical practices of educators, this study aligns itself with the view of Manny-Ikhan et al., (2011), that technology (IWB) has a potential in assisting with classroom interaction but instructional method still lies in the hands of the educator.

Chapter 4

4.1 Research Methodological Approach

A qualitative case study has been used for this research. Stake (1995) describes the case study as "placing an interpreter in the field to observe the workings of the case, one who records objectively what is happening but simultaneously examines its meaning and redirects observation to refine or substantiate those meanings" (p. 8-9). This was ideal for examining participants in depth and also exercising objectivity within the process. Millian and Schumacher (2006) describe qualitative research as an understanding of a social situation from participants' point of view. With regard to this research study, it aimed at investigating the pedagogic practices of Grade 11 Maths teachers when using the IWB to deliver Maths lessons. The outcomes of the research depended much on the experience of participants (teachers) in responding to the questionnaires related to Mathematics content knowledge, and how they used the IWB to teach. The collected data has informed the extent to which Grade 11 Maths teachers' use IWB to deliver Maths lesson in the classroom. The outcome of the research study has had positive impact on both schools, since teachers' practices in using IWB can be challenged, or may be questioned in order to yield quality teaching and learning.

The qualitative methodology was used because the study is subjective, and it intends in a relative way to construct the truth about the topic. The study is subjective, in the sense that it focuses on the pedagogic practise of Grade 11 Mathematics teachers. This methodology has enabled the researcher to have deeper knowledge about participants since data has been generated through interviews, observations, and questionnaires. The qualitative methodology has helped to study the events thoroughly because it encourages the study of practical situations such as classroom teaching and practices of participants. It also explains the nature of practices taking place when IWBs are used in Grade 11 Maths classrooms.

4.1.1 Data Generation

The data was generated in two township-based schools (School A and School B) through questionnaires, interviews and observations. The reason to conduct the study in the two schools is that their 2016 Maths results for Grade 11 are below 65%, which is also still below the Provincial Education Department's target. Moreover, teachers in the two schools are currently using IWB to deliver Maths content. The study aims to investigate how pedagogical affordances of IWBs encourage interaction in the two schools. More emphasis was put on the way IWBs influence the delivery of Maths content.

The study used questionnaires, interviews, and observations to generate data. 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 the data generation economical, and has encouraged the anonymity of the participants. The interviews afforded the researcher direct interaction with the participants. Issues that have not been picked from the questionnaires were addressed during interviews. The study has also used observations technique to generate data. The technique is known to be subjective, however it enabled the researcher to compare what has been gathered from questionnaires and interviews.

Data generating techniques are briefly discussed below:

Questionnaires

A questionnaire is regarded as an instrument that has open and closed questions with which respondents must interact (McMillan & Schumacher 2006, p. 195). A questionnaire was used as a technique to obtain information from the subjects (McMillan & Schumacher 2010). All Mathematics teachers have answered one common questionnaire. This has encouraged uniformity and consistency from all participants (teachers responding to questions), and the possibility of receiving adequate and relevant information from the participants. Both open and closed-ended questions have been used to gather enough information about the extent to

which Grade 11 Maths teachers use IWBs to deliver Maths lesson in the classroom. The use of open-ended questions enabled the researcher to gather enough data from the participants, while the closed questions helped in making comparison amongst the focus group. Moreover, the closed questions assisted obtaining answers that are more focused on the research topic. From Cohen, Manion and Morrison's (2011) perspective, closed questions "are useful in that they can generate frequencies of responses amenable to statistical treatment and analysis" (p. 382). Usage of the two types of questions (viz. both open-ended and closed) has enabled the researcher to extract more information from participants. Furthermore, participants also expressed their opinions through writing and ticking the boxes.

Two teachers per school were used to assist in distributing and collecting the questionnaire. Questionnaire and interview questions were given to the participants during lunch time (break), and participants were given seven days to respond to the questionnaires. To enhance trustworthiness in the study, terminologies of abstract words such as IWB and Information and Communication Technology were explained to teachers for the sake of clarity.

Interviews

The study has used interviews that are semi-structured to allow participants to freely respond and give more specific details. Interviews afforded the researcher an opportunity to have face-to-face conversations with the researcher, asking questions and noting or recording the response of the participants. Through interviews, the researcher had the luxury of clarifying and also simplifying questions to avoid misconceptions and ambiguity. In order to ensure that enough information is gathered from the participants, the researcher has elicited information through probing the respondents. Probing in semi-structured interviews necessitates for elicitation, elaboration for details, further explanations, and clarification of responses (McMillan & Schumacher, 2006). McMillan and Schumacher (2006) acknowledge the advantages of interviews, but the author also feel that "depending on the training and expertise of the interviewer, the respondent may be uncomfortable in the interview and unwilling to report true feelings" (p. 205). Over and above that, McMillan and Schumacher (2006) insist that

interviews have disadvantages, because they hold a potential for subjectivity, where the interviewer can be biased, and they might have a higher cost and time-consuming nature, and lack of anonymity. In order to eliminate the bias, McMillan and Schumacher (2006) argue that the interviews ought to be used as neutral medium as possible through which information is shared.

Interviews have cleared misconceptions and misunderstanding that the researcher had during lesson observation. Participants were free to give more explanations about their practices and perceptions when using IWB to deliver lessons. Moreover, one-on-one interviews provided the possibility of providing a relaxed atmosphere, where the information gathered becomes more detailed and systematic.

Observation

According to Chaleunvong (2009) observation "is a technique that involves systematically selecting, watching and recording behaviour and characteristics of living beings, objects or phenomena" (p. 7). Observation technique is commonly done in a social space where the researcher decides to participate in the research group, or observes without participating in the situation. When the observer becomes part of the participants, the researcher focuses on his role as observer in the situation. The observer who is not participating in the situation watches the situation, whether openly or concealed, and without being immersed in the situation (Chaleunvong, 2009).

The study used a complete observation technique, which ensured that the researcher does not participate in the situation. Even if this technique may be limited where the observer does not become immersed in the situation, questionnaires and interviews helped in clarifying what has been observed during the lesson. The observation technique provided evidence of teachers' practices in the classrooms. The presence of the researcher in the classroom has caused the teachers and learners' behaviour to change minimally, because they are being monitored. Even though observations have influenced learners or teachers' behaviour, they enabled the researchers to give imbalanced feedback that does not rely to the perceptions of teachers.

4.1.2 Data Analysis

Analysing data in qualitative research involves "organising, accounting for and explaining the data; in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities" (Cohen, Manion & Morrison, 2011). Data has been presented and analysed from interview questionnaire, interviews, and observations. The research has attempted to give detailed and rich data since data was generated from a small group of six participants. The study used direct phrases in order to maintain authenticity. The generated data was refined accordingly, so as to avoid data overloading (Cohen, Manion & Morrison, 2011). Data analysis has been presented per participants of one school, and followed by participants of another school. Total responses from questionnaire, interview and observation of an individual participant have been presented before analysis can move to the next participant. Each school has been classified according to letters: 'A' referred to School A, while 'B' referred to School B. Participants have been assigned nicknames: 'Limpopo' referred to Participant 1, 'Tugela' referred to Participant 2, and so on.

Questionnaire

Data was analysed from open-ended and closed-ended questions. To preserve coherence and integrity of the participant's response, the research used direct responses from open-ended questions. Frequency of responses from closed-ended questions were analysed according to participant's experience about ICTs, access to IWB and usage of IWB.

Interviews

Responses from individual participants were summarised without changing their meaning. The summary has attempted to give an over view of the participant's responses.

Observations

The researcher has used observation sheet to present participants' classroom practices. The findings from observation sessions were summarised and presented in a manner that give an overview of the classroom practices.

4.1.3 Issues of trustworthiness

This section has covered issues of credibility and authenticity to maintain trustworthiness of the research. Below is a summary of each trustworthiness aspect.

Credibility

The use of questionnaires has helped to facilitate credibility, confirmability, and authenticity of the research. To ensure that the research study is authentic, it should produce consistent and accurate results, even over time. This simply implies that if the research can reproduce the same results under the same methodology, then the research instruments are considered to be creditable. Triangulation of data, which maximises credibility, is enabled by the selected method of data generation in this study, such interviews, questionnaires, and document analysis. Based on Golafshani (2003) triangulation, this is regarded as a strategy or test for improving credibility and authenticity of the research and this is done through multiple data generation methods. This methodology involves a number of data sources in an enquiry in order to produce a broad understanding of the problem being investigated.

The use of interviews and observation in this study enabled the researcher to fully understand people's situations and experiences, enabling the researcher to intensely search and probe for further information. Moreover, interviews allow face-to-face interaction which enables the researcher to obtain in-depth information through probing. Unlike questionnaires, interviews encouraged social interaction and questions and answers were clearly explained. Interviews afforded both the researcher and the participants to rephrase their questions or answers. Participants were able to give more reliable information during interview. The researcher was also able to evaluate the situation and ask for relevant information 'on the spot', thereby enhancing credibility. Using different Grade 11 Maths teachers in the two schools has ensured consistency of results and more accurate information.

Authenticity

The fact that the researcher used Mathematics teachers and heads of the department (Mathematics) to generate data has enabled consistency of the study. The use of questionnaires has ensured that participants provide accurate and adequate information, since

they have given different perceptions about the topic. The authenticity of the research was checked by comparing the realities with the results of the data collection instruments. Different data generation instruments helped to improve the authenticity of the research and also promoted triangulation of data. In order to maintain creditability and authenticity within the study, classroom observations were done in order to avoid generating data from incomplete questionnaires and interviews.

4.1.4 Sampling of Data

The study used purposive sampling. Scott and Morrison (2005) describes purposive sampling as a form of non-probability sampling where the researcher selectively chooses population based "on the terms that apply to the researcher" (p. 221). The research study used two Grade 11 Mathematics teachers and one departmental head from each school as a population sample. Grade 11 teachers were purposefully chosen in order to check their practices in the IWB classrooms. Departmental heads are believed to be knowledgeable about Maths content in schools, thus their selection was purposeful. The population of the research study therefore consists of six participants.

All Grade 11 Maths teachers and departmental heads in each school responded to the questionnaires, interviewed and observed while delivering Maths lessons through IWB. The researcher used the sample to determine how IWBs are used in the Maths department to enhance teaching and learning. The outcomes of the research in the two schools helped the researcher to further explore teachers' practices when using IWB.

4.1.5 Size

The study has six (6) participants in total. Each school had three participants which include: one Maths Head of the Department (HoD) and two Grade 11 Maths teachers. Lesson observation, questionnaires and interviews were administered to the six participants to check their perceptions and practices when using IWBs in Maths classrooms.

4.1.6 Areas of study

The setting of this study focused on two Gauteng secondary schools in Ekurhuleni North District whose office oversees all schools in the district. The rationale in selecting this district is that the current MEC for education has spent millions of rands to equip them with ICT resources such as IWBs. The two schools are situated in the heart of Tembisa Township located on the eastern side of Johannesburg. They are both public schools and were previously disadvantaged in terms of ICT resources and infrastructure. They both have IWBs in Grade 11 and 12 classrooms. All learners (from Grade 8 to 12) in both schools are using tablets installed with e-Books and e-content for learning. Individual teachers in both schools were provided with laptops loaded with personalised content according to the subject they teach. The study will help teachers to explore pedagogic practices of Grade 11 Maths teachers when using the Interactive Board to deliver content.

4.1.7 Ethical Issues

In the faculty of Social Science, human beings participated in the research. Therefore, according to Creswell (2012), researchers ought to be sensitive of people's perceptions and respect the privacy of individual participants. Before the research can be conducted, an application was submitted to the University of the Witwatersrand Ethics Committee for ethical clearance. Another application was send to the Gauteng Department of Education (GDE) to be granted a permission to conduct this study within Ekurhuleni North District schools. The ethics committee granted the researcher ethics clearance, and permission to collect data in the two schools was granted by the GDE. The researcher started to engage all the participants after receiving ethics clearance and GDE approval letter. The ethics approval verifies that in a proposed study participants were protected from harm and that their rights to privacy has not be compromised.

An information sheet containing the details on the research and a written consent form was send to the participants. All the participants were informed that their participation is voluntary and that confidentiality and anonymity is assured. Participants were also informed of their rights and that they are at liberty to either continue to participate or withdraw from the study.

Their names or school names were not used in this study, they were assigned nicknames which were used to manipulate and interpret data.

4.1.8 Limitations of the study

This research study would have included all Gauteng schools that use IWB to enhance teaching and learning in the classroom. However, due to time constraints for the University's research course, the researcher was constrained to focus on only two schools. The study aimed at establishing the extent to which IWBs are pedagogically integrated in the classroom, and the way in which these influence the pedagogic practices of teaching Mathematics. Moreover, only Grade 11 Mathematics teachers in the two schools participated in this research project. The researcher would have liked to include all teachers who use IWB to teach in the two schools, but due to time constraints, the study could not cater for all users of IWB.

Chapter 5

5.1Data presentation

5.1.1 Participants Codes

The findings are presented here according to the participant's responses from questionnaire, interviews and observations. The same order has been followed until the last participant. This is followed by a summary of participants' ICT and teaching experience. The last part of the presentation focused on the participants' responses based on the research questions. The six participants have been assigned codes as follows:

Limpopo- represents Participant 1 from school A

Tugela- represents Participant 2 from school A

Pongola- represents Participant 3 from school A

Mogalakwena- represents Participant 4 from school B

Letaba- represents Participant 5 from school B

Indwe- represents Participant 6 from school B

5.1.2 Background of the schools

As previously mentioned in the section discussing "areas of the study", the two no-fee paying public secondary schools that participated in this research study are situated in Tembisa Township. Both schools have Grade 8-12 classrooms, and their roll includes more than 1400 learners. Teachers in the two schools are using IWBs in Grade 11 and 12 classrooms to enhance teaching and learning. Learners from both schools have started benefiting from the e-Solution

project since 2015. The two schools are part of the six schools which were piloted for e-Solution project by the current MEC of Education.

5.1.3 Teacher profile

The information below represents the profiles of Mathematics teachers (participants) in the two schools.

Limpopo: Is a female teacher with five years of teaching experience. She has been teaching Mathematics in the past two years and has used the IWB for a year. She is classified as a moderate IWB user.

Tugela: Is a female teacher with fourteen years of teaching experience and has less than a year using IWB to teach. She has been teaching Mathematics for ten years and is classified as a novice IWB user.

Pongola: He has fifteen years of teaching experience, with more than two years using the IWB to teach. He is a HOD and has taught Mathematics for more than six years. Is classified as an advanced IWB user

Mogalakwena: He has more than twenty five years of teaching experience, with more than two years using the IWB to teach. He is a HOD and has been teaching Mathematics for more than fifteen years. Is classified as a novice IWB user.

Letaba: Is a male teacher with ten years of teaching experience and has more than two year using IWB to teach. He has been teaching Mathematics for eight years. Is classified as a moderate IWB user.

Indwe: Is a male teacher with four years of teaching experience and has more than a year using the IWB to teach. He has been teaching Mathematics for almost three years. He is classified as an advanced IWB user

5.1.4 Participants

The participants in this research are six teachers from two schools (three teachers from School A and another three teachers from School B). The six teachers are classified as Limpopo-Indwe. The summary of participants' responses is summarised as follows:

School A

Below are the findings for Limpopo, Tugela and Pongola

Limpopo (Moderate IWB user)

Below is the data collected from Limpopo through a questionnaire, interview and classroom observation. Participant responses are transcribed verbatim.

Questionnaire

Limpopo was classified as a 'moderate' IWB user and has less than five years of teaching experience. She has been teaching Mathematics in the past two years with more than one year using the IWB to teach. Limpopo can access eBooks and other education programmes installed on the board. The participant has access to IWB and is also able to use interactive gallery contents, shapes and videos. However, linking of other devices such as cell phones, tablets and laptops to the IWB appeared to be a challenge to her. The participant has limited skills on IWB interactive tools and can't develop a lesson using IWB interactive tools.

Limpopo indicated that she used the IWB to prepare and teach Mathematics. Through different colours, the participant insisted that learners are able to conceptualise concepts that are displayed on the IWB different from the ones written on the chalkboard. When the participant was asked how the IWB influence learner participation and she responded as follows:

"Through pictures and diagrams that are displayed on the board, learners' focus tends to increase since they see variety of things. Learners started to conceptualise content in a more structured manner."

When it comes to the usage of IWB in promoting the learner-learner, learner-content and learner-teacher interaction, Limpopo answered as follows:

"Availability of quizzes from the IWB encourages learners to brainstorm ideas and work together in achieving solutions to the questions, the availability of extra content that consist of visuals and audio encourages learners to interact with content. Lastly, abstract concepts that learners find it difficult to understand makes them to be highly engaged with their teachers."

The participant also mentioned that through IWB, teachers are able to mediate abstract concepts which help learners to construct new knowledge.

Interview

Limpopo has shown a higher level of interest in teaching with IWB than a chalkboard. Different tools that have animations on the IWB were cited as important, benefiting learners by offering learning approaches. Limpopo indicated that the IWB saved her time because notes can be carried from one class to the other, and as such, her lesson objectives are always met. She insisted that the use of media files helps teachers to deliver content in a smarter manner. When Limpopo was asked about the way in which the multimodality of IWB influences her teaching approach, she highlighted that:

"The availability of internet based videos, pictures and multimedia files enable her to teach in a manner she can bring visuals, sound clips and row content to the classroom."

Observation

The participant has used IWB in her pedagogy. There was evidence of learner-learner, learner-content and learner-teacher interaction. Learner participation was high, because the teacher has successfully integrated the IWB with the subject content to support teaching and learning. The participant has managed to promote a teacher-learner interaction approach through discussing the lesson challenges. The participant dominated the lesson, however learners were also given a chance to interact we with the content and the teacher.

Tugela (Novice IWB user)

Below is the data collected from Tugela through a questionnaire, interview and classroom observation.

Questionnaire

Tugela was a novice IWB user with less than a year using IWB to teach. She was in her late forties with fourteen years of teaching experience and has been teaching Mathematics for ten years. Her level of experience about ICTs is low and was struggling to manipulate tools on the IWB to suit her lesson. She was able to access the IWB daily. The participant was also able to access e-Books and few programmes that are pinned on the taskbar. Furthermore, she was able to use the gallery contents and shapes to teach. Even though there was full access of IWB, the participant had limited knowledge of creating animations using objects' properties. Linking of IWB with other ICT tools was a challenge. Usage of internet was at minimal level.

Tugela relied on e-Books and previous question papers to teach. The IWB was used to present slides that were prepared on PowerPoint. Learners were asked to copy note that were hand written on the board. The participant has used the IWB as a chalkboard, because free-hand writing was done to emphasise concepts. No multimedia file was used to teach. The participant has successfully pinned e-Book pages that have diagrams in order for learners to answer questions based on the pages. Learner-content interaction was encouraged, achieved through exposing learners to more comprehensive word problems from the previous question papers.

Interview

The participant has recommended teaching using IWB, because it minimised the burden of rewriting what is the textbook. Tugela mentioned that the use of IWB is benefiting her, because rich and extended material can be accessible from external devices. She also highlighted that learners' computer literacy level makes it easy to interact with content. Learners actively participate during the lesson by sharing notes and discussing ways of using the board to access subject content. Interaction of learners helps in achieving collaboration and learners at all learning levels are accommodated.

Tugela explained the way in which multimodality of IWB influences her teaching approach as follows:

"The use of visual and text help learners to conceptualise Maths content differently as compared to when they are taught using textbooks only. IWB is able to give clear colours that

correctly give the representation of a diagram, picture or object. The fact that users can bring objects closer gives users advantages."

Observation

Tugela has used IWB mostly for visuals. The IWB was used as a basic technological tool since there were no attempts to use the IWB to creatively expand teaching and learning opportunities. Even though the teacher did not have high ICT skills level, learners were encouraged to actively participate during the lesson by interacting with the content (in the form of picture and diagrams) on the IWB. The participant has used the IWB to promote teacher-learner centred approach through question drilling method.

Pongola (Advanced IWB user)

Below is the data collected from Pongola through a questionnaire, interview and classroom observation.

Questionnaire

Pongola has almost fifteen years of teaching experience and has been a HOD for more than five years. The participant has taught Grade 11 Mathematics for more than six years. His experience with ICT resources is high and has more than two years using the IWB to teach Mathematics. Pongola was able to present various learning content on the board and could also navigate through the board without any difficulty.

The participant indicated that the IWB has helped him to teach Mathematics concepts in a more practical way. The participant was using a Geogebra (Mathematics programme) to plot different graphs. The use of Geogebra has made the participant to teach Mathematics in a more graphical and practical manner. The programme afforded the participants an opportunity to rotate, flip, and shift diagrams to suit his lesson objective. The use of IWB has improved learner participation, because learners are always challenged to preview concepts in more than one manner. Pongola highlighted that learners' attention in the classroom has improved since they are always engaged with interactive activities. Through more abstract concepts on Geogebra, Pongola indicated that learners were forced to seek help from their fellow class

mates and from the teacher. And the use of Geogebra has encouraged teacher-learner, learner-learner and learner-content interaction

Interview

Pongola has found teaching through IWB interesting and beneficial since assessment was administered through linking the board with tablets. Access to a variety of extra audio visuals and other material on the internet enabled all learners to be accommodated in terms of their competence level and diversity. When Pongola was asked how IWB helped him deliver content differently from traditional teaching approach, he responded as follows:

"Use of media has made teaching to be more meaningful and practical, presenting through IWB has made teachers to prepare beyond textbook scope."

The participant has hinted that the multimodality of the IWB has made teaching of Mathematics to include more visuals, audios and interactive activities.

Observation

The participant has pedagogically used IWB to establish new concepts and learners were seen to be more interactive with the content. The participant has creatively used IWB to expand teaching and learning opportunities and different learning styles were accommodated. Learners were highly engaged and participating during the lesson. The participant has used variety of teaching approaches in an innovative way in order to meet his lesson objective.

School B

Below are the findings for Mogalakwena, Letaba, and Indwe

Mogalakwena (Novice IWB user)

Below is the data collected from Mogalakwena through a questionnaire, interview and classroom observation.

Questionnaire

Mogalakwena was the most experienced teacher in this study, with more than twenty-five years of teaching experience, and has occupied a HOD post for almost ten years. He has been

teaching Mathematics for more than fifteen years. His experience with ICT resources is low, and he has been using the IWB to teach Mathematics for more than two years. The participant can access and use few teaching and learning tools on the board. Manipulation of teaching and learning tools and applications on the IWB can be done through the assistance of learners.

The participant showed limited ability to use tools and objects that support learner interaction. However, through learners' assistance, he managed to allow learners to discuss, and respond to questions on the IWB through tablets. The lesson activity tools were used to support active learning. When Mogalakwena was asked how he uses the IWB to enhance teaching, he answered as follows:

"All learner activities are saved on the IWB for future use; these activities are easily modified and corrected to suit the lesson of the day."

Mogalakwena highlighted that learner concentration becomes higher when they see images and sounds. He insisted that through IWB, the illustration of concepts becomes easy.

Interview

The participant explained that learners were given a chance to manipulate Maths concepts on the IWB in order to ensure that all diverse learners are accommodated. When Mogalakwena was asked about how the interactivity of IWB assists in achieving lesson objectives, he explained that:

"Through moving objects around the board, learners are able to view Maths concepts in different forms, learners become aware that objects can be rotated and reflected to form a new shape."

Mogalakwena mentioned that, through IWB, teachers are able to use objects or shapes that can be viewed in many dimensions, and this makes teaching through IWB different from the traditional way of teaching. The multimodality of the IWB caused teachers to better their teaching, since lessons are easily reviewed and restructured to suit learners' needs.

Observation

During lesson presentation, Mogalakwena was limitedly using tools on the IWB to explain and reveal concepts. The participant was using few tools on the IWB to support subject content. Learner participation was achieved through giving learners activities that required them to collaborate and refer from the textbook. Learners were given abstract activities which challenged them to seek help from the teacher. The lesson was highly dominated by both the teacher and learners. Learners used IWB individually to draw graphs and explained how variables of the graphs affect the shape, turning point and coordinates of the axis.

Letaba (Moderate IWB user)

Below is the data collected from Letaba through a questionnaire, and interview, as well as classroom observation.

Questionnaire

Letaba has ten years of teaching experience and has been teaching Mathematics for eight years. The participant has been using IWB to teach for more than two year. He has been using various ICTs and other software applications to enhance teaching and learning. The participant has successfully linked other ICTs such as learner's tablet and laptop with IWB.

Letaba has used IWB tools such as shapes and gallery pictures to teach. This has made his lessons more meaningful where leaners were able to differentiate features of various geometric shapes. When asked how he uses the IWB to promote learner-content, the participant said that is achieved through:

"Connecting tablets with the IWB."

A smart response programme was one of the types of software used to encourage learner-learner interaction. Learners' attention was maintained through giving them individual tasks that needed to be completed within a short space of time.

Interview

Letaba indicated that teaching with IWB is interesting because it brings colour and motion. He highlighted that his lesson objectives were achieved because he used presentations other than

writing on the chalkboard. When asked about how IWB helps him deliver content different from the traditional teaching approach, he indicated as follows:

"With the addition of videos, animations and graphics, many lessons have 21st century based skills which are more relevant to the learners of today."

The participant emphasised the importance of using IWB and he argued that IWB allows for many means of presenting information. He finally stressed that through IWB, more media-based lessons can be in cooperated into Maths lessons.

Observation

Even though Letaba seemed very experienced in using the IWB, he spent more time displaying diagrams and shapes on the IWB. The IWB was used to present visuals other than presenting videos and multimedia content. Since Letaba took most of the teaching time explaining Mathematics shapes on the IWB, the lesson was teacher-learner centered. The participant has managed to connect the laptop with IWB to display extra content that is on the laptop. Technology (IWB) was used to support subject content. Learners were engaged during the lesson since they were individually answering class activities.

Indwe (Advanced IWB user)

Below is the data collected from Indwe through a questionnaire, interview and classroom observation.

Questionnaire

Indwe was classified as an advanced IWB user. The participant has four years of teaching experience and has been teaching Grade 11 Mathematics for almost three years. Indwe has started using the IWB to teach Mathematics in 2016. He frequently used other ICT resources such as laptop, compact disks and television in the lower grades. The participant can navigate through educational programmes installed on the IWB. Linking of IWB with a laptop and learner's tablets was done with ease.

When the participant was asked about how IWB helps him to teach, he responded as follows:

"The IWB makes teaching easy because it has applications that support enquiry learner and learner independence."

Indwe felt that learners were highly focused on learning materials that showed 2D and 3D diagrams. He felt that through the use of IWB, learners' attention is highly retained because they become problem-solvers rather than simply being passive learners. He also hinted that through collaborative activities such projects, learners are forced to interact amongst themselves, but are required to interact with the content and teachers.

Interview

Indwe indicated that the use of IWB benefits him since he does not rely on one source to teach. The use of internet benefits both learners and the teachers since they have an opportunity to interact with variety of sources. The participant stated that the use of various applications with features such as sound, three-dimensional and videos help him to accommodate diverse learners. The installed eBooks helped him to focus on the scope of the subject and his lesson objectives are always met. When asked about how the IWB has helped him deliver content differently from the traditional teaching approach, he noted that:

"I use innovative methods of teaching and learning by effectively using ICT, demonstrating experiments and drawing of graphs by means of Geogebra."

In relation to the multimodality of IWB, the participant indicated that, IWB brings real life experience in the classroom because it can project videos, audio and animations.

Observation

The participant has used IWB in an innovative way to teach new concepts. Learners were highly engaged as they were solving complex Mathematics questions on the IWB. A variety of teaching methods were used to accommodate learners who need additional support. The participant used the IWB in a way that supports different learning style. Learners were highly engaged and participation was high during the lesson. Indwe used the IWB and instructional approach to support a learner-centred approach.

Summary of participants from school A and B

The three participants from School A (Limpopo, Tugela and Pongola) vary according to their teaching experience, ICT skills level and the way they utilise the IWB for teaching and learning. The novice or beginner IWB user (Limpopo) has less than fifteen years of teaching experience and has been using the IWB to teach for less than one year. The moderate IWB (Tugela) user has less than five years of teaching experience and has been using the IWB to teach for more than a year. The experienced IWB user (Pongola) has almost fifteen year of teaching experience and has been a HOD for more than five years. Pongola has more than two years of experience using the IWB to teach.

Participants from School B (Mogalakwena, Letaba and Indwe) had different experience in terms of teaching, ICT skills level, and usage of IWB. From the three participants, the teacher with the most teaching experience (Mogalakwena), head of the Mathematics Department, had little IWB-related skill. Letaba had high ICT skills and has integrated different ICTs (IWB included) within the school curriculum. The last participant (Indwe) has used various ICTs for teaching and learning from the past three years. Indwe has used collaboration features of the IWB in an innovative way to ensure high learner participation in the classroom.

The responses from all participants showed that they prefer using IWB over chalkboards since they have all noted the advantages of IWB. They have all benefited from using IWB, and have shown ways in which IWB have influenced their Maths content delivery in the classroom. The data presentation showed the way in which IWB facilitated interaction amongst learners, content, and teachers which relate to Carmean and Haefner's (2002) theory of knowledge construction through interaction. Regardless of their ICT skills, the use of IWB has enabled the possibility of having learner-centred lessons than teacher-centred lessons.

5.1.5 To what extent does the pedagogical affordance of IWBs support interactivity in the classroom?

All participating teachers expressed their views about the pedagogic affordances of IWB. Teachers value the use of IWB in teaching and they believe that through the use of IWB in the

classroom high interaction is achieved. Evidence of teachers' views about the pedagogical affordances of IWB in supporting interactivity in the classroom was recorded as follows:

Limpopo highlighted that:

> "Availability of quizzes from the IWB encourages learners to brainstorm ideas and work together in achieving one goal, the availability of extra content that consist of visuals and audio encourages learners to interact with content. Lastly, abstract concepts that learners find it difficult to understand makes them to be highly engaged with their teachers."

Tugela and Pongola shared the same view that the interactivity of the IWB has exposed learners to more comprehensive Maths concepts. Tugela explained that, learner-content and learner-learner interaction was achieved through:

> "Sharing of notes and discussing ways of using the board to access subject content installed on the board. The interaction of learners helps in achieving collaboration and learners at different all learning levels are accommodated."

Pongola reported that the pedagogical affordances of IWBs support interactivity in the classroom in the sense that learners are:

> "Able to rotate, flip and shift diagrams to suit the lesson objective. Learner participation has improved because they are always challenged to preview concepts in more than one perspective. Learner attention in the classroom has improved because they are always engaged with interactive activities. Through more abstract concepts on Geogebra, learners were forced to seek help from their fellow class mates and the teacher. And this encouraged teacher-learner, learner-learner and learner-content interaction." The abstract Geogebra concepts encouraged learners to enter into a discussion since they were expected to report on their findings about the concepts.

Even though Mogalakwena had limited ability to use the IWB to support learner interaction, he demonstrated how affordances of IWB support interactivity in the classroom by allowing learners to discuss and respond to questions on the IWB through tablets. Mogalakwena explained how interaction is achieved as follows:

> "Through tablets, learners were forced to discuss questions before they could provide answers. Learner-content interaction was achieved through giving learners activities that needed individual attention. Learner attention became very high since they needed to interact with Maths content without any disturbance."

Indwe shared a similar view to that of Letaba about how affordance of IWB retains learner's attention. He shared the observation that through the use of IWB, learners become problem-solvers, rather remaining passive learners. He also mentioned that:

> "Collaborative activities encourage learners to interact with content, teachers and other learners."

From Letaba's perspective, the pedagogical affordances of IWBs can support interactivity in the classroom only if learners are given tasks that retain their attention. Letaba suggests, as mentioned, that such environment enables learners to become problem-solvers rather merely remaining a passive audience. He also hinted that through project-based activities, learners are forced to seek knowledge from their colleagues and teachers. Through research projects, learners are bound to interact with the subject content.

The responses from teachers seem to suggest that when IWB is used in the classroom, there is evidence of interaction (learner-learner, learner-content and learner-teacher). Teachers are starting to be aware that they should not dominate the lessons as this will result in learners being less interactive. For McGee (2003), high classroom interaction is realised where teachers have less control over the lesson. In classrooms where there is high interaction, learners become independent, self-driven, and their thinking skills becomes elevated. This is supported by Soo and Bonk (1998), as they insist that interaction amongst learners encourages collaboration and discovery during learning. Teachers in this study have demonstrated how the affordances of IWB can support interaction in the classroom.

5.1.6 How does the usage of IWBs influence the way Maths teachers deliver Maths content in the classroom?

Participants in this study have acknowledged the way in which IWB has changed their teaching approach. Even though few teachers were still using the IWB as a chalkboard, but they used

other features of the IWB to display objects and figures, video and audio files. This is evident where their lesson planning and presentation has changed to suit the capabilities of the IWB. Participants echoed their views about their classroom practice as follows.

Limpopo and Pongola shared the same sentiments about how their teaching was influenced by IWB. They insist that through IWB's affordances to display multimedia files enabled them to deliver Maths content in a modern and practical manner. Limpopo insisted that, through different colours and pictures displayed on the IWB, learners are able to conceptualise concepts better than when they are drawn on a chalkboard.

Pongola highlighted that:

> "The use of media has made teaching to be more meaningful and practical. Presenting through IWB has made teachers to prepare beyond textbook scope."

The multiple ability of the IWB to accommodate various teaching approaches has been noted as the most powerful feature of the IWB, which can be seen to have influenced how teachers deliver their lessons. Limpopo and Pongola explained that the interactive nature of the IWB enabled them to plan, prepare and deliver lessons in a more concrete and expressive manner. The availability of internet-based videos, pictures and multimedia files has enabled Pongola to teach in a manner that she can bring visuals, sound clips and row content to the classroom. Programmes such as Geogebra have enabled participants to teach Mathematics through graphics. Through Geogebra, teachers were forced to introduce their lessons by linking what is in the learner's books with what is drawn and manipulated on the IWB.

When it comes to Tugela and Mogalakwena's teaching approach, the IWB has influenced how they teach to a certain degree. One could argue that participants such as Tugela and Mogalakwena were using the IWB as a chalkboard. As far as interactivity is concerned, these participants have not taken the advantage of the pedagogic affordance of IWB. Hence, free-hand writing was used on the IWB, and no multimedia files were used during the lessons. However, the use of different colours by Tugela and Mogalakwena to highlight and emphasise concepts has surely made an impact on their lessons. In their explanation they highlighted that:

“The use of visual and text help learners to conceptualise Maths content differently as compared to when they are taught using textbooks only. IWB is able to give clear colours that correctly give the representation of a diagram, picture or object.”

Tugela and Mogalakwena also argued that through IWB, lessons activities can be saved for future use and these activities can be easily modified and corrected to suit future lesson.

Letaba and Indwe spoke at length about how their teaching was influenced by the IWB. They were both adamant that the traditional teaching method has denied learners opportunity to interact with subject content in a different format (visuals, audio, 2D and 3D dimensions). Letaba highlighted that through teaching with IWB, learner’s devices such as tablets can be linked with the IWB to ensure that content is shared amongst the devices. This makes teaching interesting since learners don’t spend much time copying notes. Teachers are able to address learning barriers through the use of videos, animations, and graphics. Different learning styles are also accommodated, through the use of visuals, sound, and graphics.

Indwe explained that the availability of the internet on the IWB benefits both learners and the teachers since they respectively have an opportunity to interact with variety of sources. This makes teachers incorporate various sources in their pedagogy, which helps to improve teaching and learning in the classroom. Letaba and Indwe emphasised that the IWB has influenced their teaching approach in a way that they become facilitators of knowledge, rather than knowledge givers. Learners are exposed to many forms of content and they are no longer confined to one learning material.

All participants in this study have shown the importance of having the IWB in their classroom. Their teaching practices have evidently changed since they have started using the IWB. Even if all participants had different IWB skills, they have, in one way or another used their skills and abilities to teach in a manner that support graphics, audio, and kinematics. The affordance of IWB has made learning and teaching in the classroom both conducive and productive. Continuous interaction amongst knowledge seekers and facilitators was demonstrated during the lessons.

5.1.7 How do IWB's pedagogical affordances expand Maths teachers' pedagogic techniques?

In relation to how affordances of IWB give Maths teachers pedagogic opportunities, participants in this study have indeed shown that the affordances of IWB has brought lot of opportunities into the classroom. Participants have also shown that they have embraced the innovative nature of the IWB, since it helped them to expand their pedagogic knowledge. All participants have acknowledged the improvement in the learning process and learner interaction, which is encouraged by the IWB. Participants hinted at how pedagogic opportunities emanate from the affordances of IWB as detailed below.

Limpopo and Tugela shared the same sentiments, that learners individually conceptualise their learning differently and this encourages them to be good negotiators and communicator. Learners conceptualise subject content better when they debate and argue about the knowledge with which they interact. The multimodality of IWB enables learners to conceptualise concepts in a more ergonomic way and their focus tends to increase when visuals are used. Tugela recommended the use of IWB where it promotes innovative thinking, rather than a learner having to rewrite what is the textbook.

Other than self-regulated learning and the support they get from teachers, Pongola emphasised that one of the pedagogic opportunities that emanates from using IWB is that it accommodates a wide variety of teaching and learning styles. Pongola has creatively used IWB to expand teaching and learning opportunities by accessing variety of extra audio-visuals and other material on the internet in order to accommodate all learners' competence level, and diversity. The use of internet has brought accessibility of extra material, and has forced learners to be critical thinkers, since they are challenged by the new content.

Mogalakwena and Indwe shared same views with Pongola about how the affordances of IWB promote collaboration in the classroom. Mogalakwena and Indwe have emphasised that the project-based activities designed on the IWB encouraged enquiry learning and team work. Indwe felt that learners became actively engaged in problem solving and are afforded the chance to meaningfully construct knowledge through social interaction. Mogalakwena supports Indwe by indicating that abstract activities derived from the IWB encourages learners to seek

help from their peers as well as the teacher. This eventually led to a learning environment that encourages learners to be researchers, presenters of knowledge, and good communicators.

Although Indwe shared same feeling with the rest of the participants about IWB's pedagogic opportunities, he argued that learning objectives are easily achieved when teachers demonstrate experiments and drawing the graphs through Geogebra programme. Indwe has used the IWB and instructional approach to support a learner-centered approach by engaging learners with activities that draws their attention. Mathematics is known to be an abstract subject, teachers find it difficult to relate it to the learner's life experience. However, Indwe demonstrated that he leveraged the multimodality of IWB by bringing real life experience in the classroom through videos, audio and animations. For him, the multimodality of IWB has enabled him to use variety of teaching methods to accommodate different learning style and needy learners.

Taking from all participants' practices in the classroom, it is evident that the participants have adopted a modern teaching approach which encourages active participation learning, as well as enquiry-based and self-regulated learning through IWB. This is in line with the findings of Hammond (2010), who advocates for cognitive affordances which serves as learning interactions between cognition and technology. Angeli and Valinides (2009) regard cognitive affordance as a concept that is associated with pedagogic ICT affordances because they both relate to the interaction between the cognition and technology. Through the affordances of IWBs Maths teachers have started to become mediators of learning, and learners have started to become active learning participants, who construct their own learning through interaction.

Chapter 6

6.1 Data Analysis

6.1.1 Introduction

The data generated from this empirical research aims to provide an in-depth analysis of the pedagogical affordances of IWB in supporting the classroom interaction. The classroom interaction has informed the study about the nature of pedagogical practices of Maths teachers when using the IWB. The primary research question that the study aims to answer is "How does the pedagogical affordance of IWBs support learners-content, learners-teacher and learners-learners interactions in the teaching of Mathematics in Grade 11?" and this question was broken down into three discrete parts.

1. To what extent does the pedagogical affordance of IWBs support interactivity in the classroom?
2. How does the usage of IWBs influence the way Maths teachers deliver Maths content in the classroom?
3. How do IWB's pedagogical affordances expand Maths teachers' pedagogic techniques?

In trying to address the above- mentioned research critical questions, this chapter gives analysis of the data presentation based on the participants' responses.

6.1.2 To what extent does the pedagogical affordance of IWBs support interactivity in the classroom?

Introduction of IWB in the classroom will not automatically transform teaching and learning in the classroom (Smith, Hardman & Higgins, 2006). Both teachers and learners ought to take advantages of the pedagogic affordances of IWB to ensure that quality teaching and learning is taking place through constant interaction with the content. Lack of "information regarding IWB's pedagogy and pedagogical practices could lead to teachers" delivering knowledge that is insufficient and ineffective (Wong, 2013, p. 2). The study has shown that participants such as

Tugela and Mogalakwena had limited knowledge about the pedagogic interactive tools of IWB. Both participants could not fully utilise these tools to support learner interaction in the classroom. Even though Tugela and Mogalakwena had limited IWB skills, they managed to allow learners to interact with the content through rotation and manipulation of objects. This interaction could only be achieved because the IWB comes with the technical and physical interactivity other than a chalkboard that does not have interactive feature.

The findings of this study revealed that teachers such as Tugela and Pongola have managed to use the technical interactivity of the IWB to flip, rotate and manipulated data to suit the learning objectives. It is also clear from the data that teachers in this study have successfully used the affordance of the IWB to support the classroom interaction. The study has also shown that the physical interaction was indeed executed by all participants, since they all managed to deliver content through IWB and also allowed learners to interact with the board. Even if teachers' IWB skills were at different levels, they still managed to physically interact with the IWB.

In addition, the study has shown that developing project-based activities encourages conceptual interactivity through enquiry learning, and team work. The project based activities developed by Mogalakwena and Indwe encouraged learners to acquire knowledge by discussing, sharing, and evaluating their ideas amongst themselves. Limpopo and Tugela also acknowledged the affordances of IWB, arguing that learners become good negotiators and communicators when they individually conceptualise their own learning. This is supported by Beachamp and Kennelwell (2010), who argue that the IWB allows a whole class of students to share differing ideas through the use of this technology in order to create and explore, changing the ICT paradigm from "a participant in the interaction to being to tool through which to interact" (p. 8). The findings in this study are in line with Alexander (2006), who argues for a dialogic classroom that supports social interaction amongst teachers and learners.

The research study has shown that teachers have pedagogically used the IWB to support dialogic classroom. Learners have been challenged to think and interact amongst each other using variety of stimuli such as verbal, visual and kinaesthetic (Wong, 2013). To ensure that the

interactivity of the IWB is promoting high classroom participation and interaction amongst learners, Limpopo and Pongola have used informal assessment (quizzes and class activities) to promote learner-learner and learner-content interaction approach. The study has also shown that teachers have mediated learning through IWB by making sure that there is communication and collaboration.

6.1.3 How does the usage of IWBs influence the way Maths teachers deliver Maths content in the classroom?

Studies have shown that IWBs have the potential of influencing how Mathematics teachers teach content in the classroom. De Vita, Verschaffel and Elen (2014) insist that the IWBs affect classroom interaction, since it has a potential of enhancing demonstration and modelling. Teaching through IWB differs from traditional teaching since rich and blended learning and teaching materials can be accessed and presented with ease. This calls teachers to plan and prepare lessons with greater depth of content knowledge. De Vita et al. (2014) argue that when teachers are using the IWB to teach, their lesson structure ought to maintain a structure which offers learners an opportunity for cognitive growth. Teachers in this study acknowledged that the IWB enabled them to stored and retrieve content for future use. Their planning and lesson presentation revolved around linking of previous content stored in the IWB in the form of e-Books or electronic-Content (e-Content).

Participants in this study have highlighted the importance of visuals, colours and animations which helped them to deliver lessons in a meaningful and practical manner. Teachers use IWB to reinforce conceptual knowledge through different visual representation. For Somekh, Haldane, Jones, Lewin, Steadman, Scrimshaw and Stuart (2007), learners who are exposed to IWB and are effectively and efficiently taught using this technology have high chances of doing well in class. Many studies have also found that the multiple representation of mathematical figures on the IWB enable learners to develop a distinctive mathematical knowledge, which is different to general everyday knowledge. This necessitates teachers to modernise their teaching in order to suit current 21st century teaching and learning approach.

Through colouring, highlighting and shading of figures, participants in this study have managed to emphasise and explain Mathematics concepts in a simpler form. This is in line with De Vita et al.'s (2014) notion of multiple visualisations, which suggest that the IWB has an affordance of multiple visualisations that helps in reinforcing conceptual learning. The use of different colours and shading brings more clarity to the figures and they become distinct from ordinary figures.

The ability of linking content from e-Books with what is written on the board has encouraged teachers to teach with multiple screens. This has captured learners' attention, since they were able to relate what is explained with what is on the e-Book. Sharing of Mathematics content from the IWB to learners' tablets devices enabled teachers to focus more on explaining Mathematics concepts than being worried about the time it takes for learners to copy notes. The ability to share content instantly within the classroom creates a collaborative and collective learning that is based on team work and social cohesion.

6.1.4 How do IWB's pedagogical affordances expand Maths teachers' pedagogic techniques?

The IWB's multimodality enables teachers to teach using different teaching method which aims to accommodate various learning styles. The use of different media enables learners to have a better view and understanding of the subject content. Their concentration level in the classroom is also proven to be longer, as they engage with concept in different learning modes. Based on Wong (2013), the versatility of "IWB supports several different learning styles such as visual-spatial, auditory and kinaesthetic" (p. 4). The IWB affords teachers a pedagogic teaching approach, which encourage learners to learn through watching, listening, touching and moving objects around. Learners' attention and concentration level is known be retained when they are exposed to technological tools with high multimodality, such as IWB. The multimodality of the IWB gives teachers an opportunity use instructional approach that suits learners' needs.

The IWB's touch sensitivity enables teachers to present lessons more efficiently without delaying the lesson and losing learners' focus (Wong, 2013). Teaching in such classrooms is demonstrated through support and execution of systematic content, which aims to broaden

learners' subject knowledge depth. Maintaining an innovative teaching level in the IWB classrooms demand that teachers research constantly and become lifetime learners. Participants of the study have acknowledged the affordance of the IWB which brings reality in the classroom, because learners learn by doing instead of through theory-based learning. The ability of the IWB to support active teaching enables teachers to teach and manage diverse learners in the classroom. When learners' needs are accommodated and learning is conducive, they are likely to excel in life.

Another affordance of IWB, which teachers found more important towards their classroom practice, is the efficiency and effectiveness of the IWB in exhibiting a range of diverse content from various learning platforms and web pages. Participants in this study were adamant that content accessed from various learning platform challenges learners' thinking about the subject content. This eventually elevates their thinking to become more critical and inquisitive. Their research skills are sharpened and they finally become good knowledge presenters and communicators. Learners collaborate and engage in enquiry-based learning when they are faced with project based problems in the IWB classrooms. Teachers should therefore take advantage of IWB affordances to instil self-regulated learning that is based on the conceptualisation and acquisition of correct subject content. Moreover, McLoughlin and Lee (2008) support the technology-driven classroom because they believe such technologies (IWBs) are capable of enabling students to be consumers and producers of knowledge, ideas and artefacts.

Although the IWB has affordances that are known to influence teaching in the classroom, other researchers such as Tanner, Jones, Kennewell and Beauchamp (2005) insist that these affordances should be mediated by teachers. And they argue that such teachers should have adopted an interactive pedagogy even in non-ICT classrooms. This is in line with the notion that technology alone cannot mediate learning without a teacher's influence. The study has also shown that technology alone cannot solve classroom challenges, however, it advocated the pedagogic affordances of the IWB, which has an influence on the classroom practice.

Chapter 7

7.1 Conclusion and Recommendation

7.1.1 Conclusion

The usage of IWB and its affordances in supporting classroom interaction in education resolves around pedagogic opportunities in teaching and learning. South African based research about how IWB influences curriculum delivery in schools is still not explored enough. Therefore, this study contributes insight into the technology-enabled classroom.

The research sought to determine the extent to which IWBs are pedagogically integrated in the classroom and how they influence the pedagogic practices of teaching Mathematics in Grade 11. To deeply explore the integration of IWBs in Mathematics classrooms, the study commenced by investigating the extent to which the pedagogical affordances of IWBs support learner-content, learner-teacher, and learner-learner interaction. It is explained that IWBs have affordances that pedagogically influence on how teachers deliver content in the classroom. Studies have shown that if teachers correctly mediate the usage of IWB, interaction in the classroom becomes evident.

In answering the first question, 'To what extent do the pedagogical affordances of IWBs support interactivity in the classroom?' the study indicated that the pedagogic affordances of IWB have given learners and teachers an opportunity to explore, reflect and share ideas effectively. This is, however, achieved when teachers understand the pedagogic opportunities of IWB and are able to manage the way they mediate learning in the classroom. In order achieve high interactivity on the IWB, teachers are advised to construct activities that encourage active participation and collaboration. Such teachers are known to excel, since they are capable of integrating IWB within the subject content using correct pedagogical processes.

The affordances of the IWB coupled with proper pedagogic practices are known to Influence the interaction between a learner and learner, learner and teacher and lastly learner, and content (Manny-Ikhan, 2011). The study indicated that meaningful interaction happens when there is a dialogue in the classroom. Learners construct new knowledge and evaluate their understanding when they enter into a dialogue. Teachers in this study have shown that the IWB

has provided them with scaffolding mechanisms that enable them to practically teach and interact with mathematic concepts in a modern and meaningful manner.

The second research question focused on finding out "how the usage of IWBs influence the way Maths teachers deliver Maths content in the classroom", and teachers in this research study have shown that IWB has enhanced their teaching to a more practical and modern approach. Their demonstration and modelling approaches have been enhanced since they started using the IWB. The way in which Mathematics lessons are planned and presented through IWB is different from the traditional classroom, due to the affordances of IWBs, which are capable of influencing the classroom context. Teachers cited that their teaching is more 'modern' in the sense that navigation of e-Books is done on the IWB rather than using hard copies.

The study has also shown that teachers appreciated the use of IWB, because it enabled them to share and restore subject content instantly, retain content for future use and reinforce conceptual knowledge. The multiple representations of Mathematics concepts on the board have made content mediation by teachers easy and more accessible. Through IWBs, teachers smoothly facilitated learning, where learners' learning potential was improved. This has resulted in having technology enabled classrooms that are more conducive for teaching and learning.

Considering teachers' different IWB skills level, not all teachers were fully capable of utilising the IWB to its full potential. Teachers such as Tugela and Mogalakwena have used basic features of the IWB to enhance their teaching. This was due to lack of IWB skills by the two teachers. However, the limited skills that the two teachers have could not stop them to in cooperate diagrams, visual and colourful Mathematics figures into their lesson. This was evident enough to justify that the IWB has made them plan and prepare lessons according to a holistic approach, since their lessons included visuals, diagrams, and text. Teachers in this study were adamant that through IWBs, teaching and learning has become more learner centred and knowledge has been expanded beyond classroom walls.

Regarding the investigation of 'how do IWB's pedagogical affordances expand Maths teachers' pedagogic techniques', the study has found that the IWBs have made it easy for teachers and learners to access information more quickly and simply. Participants in this study have highly recommended the use of IWB because they believe it has managed to trigger communication and collaboration in the classroom. The study found that the multimodality of the boards has encouraged teachers to use different teaching approaches. This has made teaching more interesting, since learner concentration and knowledge retention has improved.

Part of the study's findings is that teachers embraced the efficiency and effectiveness of the IWB to present content instantly. This caused teachers in this study to systematically prepare and demonstrate lessons within a short period of time. Teachers felt that the interactivity of the board has brought reality and conducive learning into the classroom. The ability of IWB to exhibit a range of content has managed to help teachers to address learners' challenges and also accommodate learners' special needs.

The study also acknowledged the importance of teachers in mediating the affordances of IWB in the classroom. The findings reveal that the IWB cannot solve all classroom challenges without the teacher's intervention. Moreover, the study encourages teachers to embrace an interactive teaching approach which will help them to fully take advantage of the pedagogical affordances of IWBs to support teaching and learning in the classroom.

Having answered all the research's critical questions, this research study has shown that indeed the pedagogical affordances of IWBs has positively influenced the way Mathematics content is delivered and has also expanded teachers' pedagogic techniques which support **l**earner-content, learner-teacher and learner-learner interactions in the classroom. The findings of the study have shown that most teachers have pedagogically integrated the IWBs to enhance their teaching practices in Grade 11 Mathematics classrooms. However, challenges teachers face in failing to fully integrate the IWB into the school curriculum has been noted in this study. These challenges ranged from poor IWB skills level to a lack of adequate teaching methodology to in cooperate IWBs in teaching and learning. To some extent, even if teachers have been

developed on the use of IWB, some teachers still find it difficult to integrate these ICTs into their teaching. This calls for the education department to monitor and support the usage of these resources in schools.

7.1.2 Recommendations

The study acknowledges the Gauteng Department of Education's initiative in equipping the township schools with IWB. The GDE has really made a life time investment in the lives of previously disadvantaged children. However, the study recommends that education stake holders should take cognisance of the fact that introduction of these technologies will not transform education on their own. Both learners and teachers ought to have a common understanding that IWB are technological tool which has affordances that can influence teaching and learning in the classroom when used properly. The extent, to which the IWB can promote learner-centred, depends on how teachers utilise these technologies.

It is also recommended that for active interaction amongst learner, teachers and subject content to take place, the IWB should be effectively utilised beyond its basic use. Even though teachers in this study were observed to be promoting group activities that demanded learners to solve problems collectively, the study recommends that teachers should use the boards innovatively in a manner that the boards are inseparable from the content. The boards should not be treated as add on tools, but they should be adequately suite the school curriculum.

The challenge of having inadequate skills to integrate these tools within the school curriculum poses a threat to the teaching fraternity. The study recommends that teachers should be equipped with proper skills and knowledge on how IWB can best be integrated within the school curriculum. The study acknowledges that all teachers were trained on how to utilise the IWB however, more support in terms of using the board to teach specific Mathematics content is important. When teachers have technological and pedagogical skills, they are likely to deliver quality teaching in the classroom.

The ability of the IWB to encourage students' participation and involvement in the classroom cannot be over-emphasised. The study recommends that teaching through IWB ought to be

transformed in a way that learners are given opportunities that enable them to contribute to their learning space. Recognising their contributions means unlocking their learning potentials and they finally become knowledge creators other than consumers of knowledge.

The study recommends further research that will investigate how the pedagogic affordance of the IWB influences learner achievement. One of the GDE's reasons to deploy these technologies in township secondary schools has been to bridge the access gap of technologies amongst Gauteng schools. However, more studies are needed to establish whether these deployed technologies have chances of influencing the pass rate positively at secondary school level. This will, in a way, justify whether the procurement of these technologies has been fruitful or wasteful.

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APPENDICES

9.1 Appendix 1

9.1.1 ETHICS CLEARANCE

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

13 October 2017

Student Number: 474704

Protocol Number: 2017ECE045M

Dear Vincent Montjane

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Investigating the Pedagogical Practices of Grade 11 Mathematics Teachers on the Usage of Interactive White Boards: A Case Study of two Gauteng Township Secondary Schools.

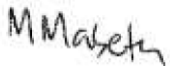
The committee recently met and I am pleased to inform you that **clearance was granted**.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,



Wits School of Education

011 717-3416

cc Supervisor Dr. Reuben Dlamini

9.2 Appendix 2

9.2.1 LETTER TO THE PRINCIPAL

DATE: 25 May 2017

Dear Principal,

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

I am doing a research on how Grade 11 Mathematics teachers integrate Interactive White Boards into their teaching. This is a case study of two Gauteng township secondary schools.

My research involves finding out how Grade 11 Mathematics teachers use Interactive White Boards to deliver content in the classroom. The research study will use questionnaires, interviews and observations to generate data. The study will be conducted during third term (In August and September 2017).

I chose your school because the Gauteng Department of Education has rolled out the e-Solution project (which includes the provisioning of Interactive White Boards 'Smart Boards') and I want to explore how these resources are being used to enhance teaching and learning.

I am inviting your school to participate in this research because it will help the school to establish how teachers are using Interactive White Boards to enhance teaching and learning. I am therefore, inviting your school to participate in this research study. 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. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about 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 as soon as it is convenient.

Yours sincerely,

VM Montjane

Vincent Mahlaseletse Montjane

21787 Motsoai Street Tsakane

vmmontjane@gmail.com

076 354 9949

9.3 Appendix 3

9.3.1 INFORMATION SHEET FOR LEARNERS

DATE: 25 May 2017

Dear Learner

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

I am doing a research on how Grade 11 Mathematics teachers integrate Interactive White Boards into their teaching. This is a case study of two Gauteng township secondary schools.

My research involves finding out how Grade 11 Mathematics teachers use Interactive White Boards to deliver content in the classroom. The research study will use questionnaires, interviews and observations to generate data. Learners will not be answering any questionnaires or interview questions. The researcher will only observe teachers while delivering Mathematics lessons in the classroom. The study will be conducted during third term (In August and September 2017).

Would you mind if I join you during Mathematics lesson to observe your teacher delivery the lesson using Interactive White Boards?

Remember, this observation will not count for marks and participation is voluntary, which means that you don't have to do it. Also, if you decide halfway through that you prefer to stop, this is completely your choice and will not affect you negatively in any way.

I will not be using your own name but I will make one up so no one can identify you. All information about you will be kept confidential in all my writing about the study. Also, all collected information will be stored safely and destroyed between 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

VM Montjane

Vincent Mahlaseletse Montjane

21787 Motsoai Street Tsakane

vmmontjane@gmail.com

076 354 9949

9. 4 Appendix 4

9.4.1 LEARNER CONSENT FORM

Please fill in the reply slip below if you agree to participate in my study called:

Investigating the pedagogical practices of Grade 11 Mathematics teachers on the usage of Interactive White Boards: A case study of two Gauteng township secondary schools.

My name is: _____

Permission to observe you in class	**Circle one**
I agree to be observed in class.	YES/NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that 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 within 3-5 years after completion of my project.

Sign_____ Date_____

9.5 Appendix 5

9.5.1 INFORMATION SHEET FOR PARENTS

DATE: 25 May 2017

Dear Parent,

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

I am doing a research on how Grade 11 Mathematics teachers integrate Interactive White Boards into their teaching. This is a case study of two Gauteng township secondary schools.

My research involves finding out how Grade 11 Mathematics teachers use Interactive White Boards to deliver content in the classroom. The research study will use questionnaires, interviews and observations to generate data. Learners will not be answering any questionnaires or interview questions. The researcher will only observe teachers while delivering Mathematics lessons. The study will be conducted during third term (In August and September 2017).

I chose your child's class because my area of study involves investigating how Grade 11 teachers use Interactive White Boards to teach Mathematics.

Would you mind if I join your child during Mathematics lesson to observe how teaching and learning take place in the classroom?

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

VM Montjane

Vincent Mahlaseletse Montjane
21787 Motsoai Street Tsakane
vmmontjane@gmail.com
076 354 9949

9.6 Appendix 6

9.6.1 CONSENT FORM FOR PARENTS

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called:

Investigating the pedagogical practices of Grade 11 Mathematics teachers on the usage of Interactive White Boards: A case study of two Gauteng township secondary schools.

I, _____ the parent of _____

Permission to observe my child in class **Circle one**

I agree that my child may be observed in class. YES/NO

Informed Consent

I understand that:

- My child's name and information will be kept confidential and safe and that my name and the name of my child's school will not be revealed.
- He/she does 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 within 3-5 years after completion of my project.

Sign_____ Date_____

9.7 Appendix 7

9.7.1 INFORMATION SHEET FOR TEACHERS

DATE: 25 May 2017

Dear Teacher

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

I am doing a research on how Grade 11 Mathematics teachers integrate Interactive White Boards into their teaching. This is a case study of two Gauteng township secondary schools.

My research involves finding out how Grade 11 Mathematics teachers use Interactive White Boards to deliver content in the classroom. The research study will use questionnaires, interviews and observations to generate data. The study will be conducted during third term (In August and September 2017).

I chose your school because the Gauteng Department of Education has rolled out the e-Solution project (which includes the provisioning of Interactive White Boards 'Smart Boards') and I want to explore how these resources are being used to enhance teaching and learning.

I am inviting you to participate in this research because it will help all Mathematics teachers to establish whether these ICT resources are appropriately used to deliver quality content in the classroom. The research will also help Mathematics teachers to evaluate their perceptions and practices when using Interactive White Boards. The study will also enable Mathematics teachers to analyse the affordances and constraints of the Interactive White Boards.

Your participation in this study will include responding to a questionnaire and interview questions. You will also be observed while delivering Mathematics lesson using Interactive White Board. You are therefore requested to provide me with all necessary information as possible.

Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

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. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

VM Montjane

Vincent Mahlaseletse Montjane

21787 Motsoai Street Tsakane

vmmontjane@gmail.com

076 354 9949

9. 8 Appendix 8

9.8.1 CONSENT FORM FOR TEACHERS

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Investigating the pedagogical practices of Grade 11 Mathematics teachers on the usage of Interactive White Boards: A case study of two Gauteng township secondary schools.

I, _____ give my consent for the following:

Permission to observe you in class	**Circle one**
I agree to be observed in class.	YES/NO

Permission to be interviewed

I would like to be interviewed for this study.	YES/NO
I know that I can stop the interview at any time and don't have to answer all the questions asked.	YES/NO

Permission for questionnaire

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

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that 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 within 3-5 years after completion of my project.

Sign_____ Date_____

9.9 Appendix 9

9.9.1 QUESTIONNAIRE FOR TEACHER AND DEPARTMENTAL HEADS

Questionnaire for Teachers and Departmental Heads

Please note the following with regard to participating in the survey

- Participation is entirely voluntary. However, given the importance of your response, you are encouraged to participate.
- It is anticipated that the survey will take no more than 20 minutes of your time. You are therefore encouraged to complete it.

CONSENT TO PARTICIPATE

Before commencing with the survey, it is important that you indicate your consent to participate by ticking on the appropriate response box below:

Consent to participate in this survey	√
I am interested in participating in this survey	
I have no interest in participating in this survey	

General Information	**Section A**

1. District Name: …….

2. Please indicate your gender
   [ ] Male [ ] Female
3. Please indicate your race
   [ ] African [ ] Coloured [ ] Indian [ ] White [ ] Other
4. What is your position in the school: ……

5. How long have you been working as a Teacher / HOD / Deputy Principal/ Principal?

   [ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 6 – 10 Years [ ] 10 Years +

6. What Subject(s) do you teach: …….

7. How long have you been teaching the subject?

   [ ] 1 – 3 Years [ ] 3 – 5 Years [ ] 6 – 10 Years [ ] 10 Years +

Your Experience With ICTs.	**Section B**

Please indicate your experience with the following: Select all applicable.

Please Indicate Your Experience With:	**Well Experienced**	**Experienced**	**Neutral**	**Not Experienced**	**Not Well Experienced**
Usage of Computers					
Usage of Overhead projector					
Usage of PowerPoint					
Experience in using digital technology to teach					
Using Interactive White Board to teach					
Manipulation of 2D and 3D diagrams					
e-Learning platform (Moodle, Blackboard, etc					
Surfing of internet					

Access to Interactive White Boards	**Section C**

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

Access to Interactive White Board (For professional use)	Yes (√)	No (√)
Do you have access to Interactive White Board?		
Did you have any Interactive White Board training?		
Are you able to access eBooks loaded on the board?		
Do you have access to other educational programmes or software installed on the board?		
Does the board have any reliable internet connection access (Local Area Network, Wi-Fi, 3G or Wire Connection)?		
Are you able to link the Interactive White Board with other ICT devices such as laptop or tablets?		
Do you have access to the interactive gallery contents, shapes and videos?		

Usage of Interactive White Boards	**Section D**

Please indicate your experience with the following below: Select all applicable.

Skills	None	Novice	Apprentice	Expert
Use Interactive White Board software to teach.				
Manipulate shapes (moving, resizing and filling in colour) on the board to suite your teaching style.				
Use the Gallery (search, insert clip art and interactive games in the gallery) to enhance your teaching.				
Group and move objects according to lesson specific outcome.				
Use Lesson Activity Toolkit (LAT) to develop an interactive lesson.				
Use My Content in the Gallery to add subject content such as pictures and videos.				
Use the screen capture to take a snap shot from another program that are relevant to your topic.				
Use the lesson recorder/smart recorder to capture the events during the lesson.				
Link web pages and pages in the Interactive White Board (Notebook) to				

expand content exposure.				
Create animations using object properties to improve information presentation.				
Create own themes and pull tabs.				
Use Smart Response (Interactive Programme) to create, export and analyse results.				
Ability to navigate through the board				

Pedagogic Practices of Teachers When Using Interactive White Boards. Section E

Please use the provided space (column B) to answer questions in column A.

Column A **Questions**	Column B **Answers**
How long have you been using the Interactive White Board to teach?	
How do you use the Interactive White Board to enhance your teaching?	
How is the Interactive White Board helping you teach your subject?	
Are there any benefits of using the Interactive White Boards?	
Has the board changed the way you used to teach?	
Are you able to manipulate information on the board to achieve your lesson objectives?	
How does the Interactive White Board influence learner participation	

in class?	
Has the usage of the board improved learner attention?	
How do you use the Interactive White Board to promote learner-content interaction?	
How do you use the Interactive White Board to promote learner-learner interaction?	
How do you use the Interactive White Board to promote learner-teacher interaction?	

9.10 Appendix 10

9.10.1 INTERVIEW QUESTIONS

Interview questions

1. Do you find teaching through Interactive White Board (IWB) interesting? If Yes how?

_____

_____

_____

2. Do you find teaching through IWB benefiting? If Yes how?

_____

_____

_____

3. How have you used the IWB to encourage learner collaboration?

_____

_____

_____

4. In what way has the IWB helped you deal with diverse learning approach in the classroom?

_____

_____

_____

5. How has the interactivity of the IWB managed to assist you achieve your lesson objectives?

_____

_____

_____

6. In what way has the IWB helped you deliver subject content different from the traditional teaching approach?

_____

_____

_____

7. In what way has the multimodality of the IWB influenced your teaching approach?

_____

9.11 Appendix 11

9.11.1 OBSEVATION SHEET

Category	Instructive	Yes or No	Interactive	Yes or No	Innovative Interactivity	Yes or No
Pedagogy	IWB used for visual only.		IWB used to explain and reveal concepts.		IWB used to establish and verify concepts.	
		Comments		Comments		Comments
Technology	IWB used as a basic technological tool.		IWB used appropriately to support subject content.		IWB used creatively to expand teaching and learning opportunities.	
		Comments		Comments		Comments
Operation	IWB used for taking of notes.		IWB used to engage students' participation.		IWB used to support different learning styles.	
		Comments		Comments		Comments
Instructional approach.	IWB used to promote teacher centered.		IWB used to promote teacher-learner centered.		IWB used to promote learner-centered.	
		Comments		Comments		Comments

9.12 Appendix 12

9.12. 1 APPROVAL LETTER FROM THE GDE

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**10 August 2017**
Validity of Research Approval:	**06 February 2017 – 29 September 2017** **2017/214**
Name of Researcher:	**Montjane V.M**
Address of Researcher:	**21781 Motsoai Street**
	Tsakane
	1550
Telephone Number:	**082 583 5204 076 354 9949**
Email address:	**vmmontjane@gmail.com**
Research Topic:	**Investigating the Pedagogical Practices of Grade 11 Mathematics Teachers on the Usage of Interactive White boards: A case study of two Gauteng township Secondary Schools**
Number and type of schools:	**Two 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.

14/08/2017

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. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this 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. *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.*
4. *A letter / document that outlines 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.*
5. *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.*
6. *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.*
7. *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.*
8. *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.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *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.*
11. *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.*
12. *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.*
13. *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.*
14. *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

.....

Ms Faith Tshabalala
CES: Education Research and Knowledge Management

DATE: 14/08/2017

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