THE INFLUENCE OF SMARTBOARDS ON THE TEACHING AND LEARNING OF GRADE 12 PHYSICAL SCIENCE IN TSHWANE DISTRICT, GAUTENG, SOUTH AFRICA

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SUMMARY

The South African education system has faced immense challenges from a lack of infrastructure, low pass rates for matric students and the high dropout rate (Mdlongwa, 2012:1). The policy brief (Mdlongwa, 2012:1) proposes that the education authorities of the national Department of Basic Education and Higher Education and Training in South Africa (SA) adopt measures that will see the use of information and communication technology (ICT) as a means of enhancing education in SA. The Government Gazette (2004:19) states that ICT has been introduced in schools to extend and improve education. In terms of pedagogy, ICT is changing the way students learn and the way teachers teach (Dzani & Amedzo, 2014:341).

According to Sekhonyane (2014:1-2), MEC Panyaza Lesufi has finalised the ICT strategy in which he declared that five schools in Gauteng will be turned into paperless classrooms. Teachers will receive tablets and classrooms will be fitted with interactive white boards in 2016. According to Mchunu (2016:1), about 1 800 Grade 12 classrooms in Gauteng Province, South Africa, have been fitted with smartboards and 64 000 Grade 12 learners were provided with tablets that had relevant content and connectivity at the beginning of the 2016 academic year.

This study investigated the influence of the smartboard in the teaching and learning of Grade 12 Physical Science in Gauteng, Tshwane District. The research question guiding this study was “How does the use of the smartboards influence the teaching and learning of Grade 12 Physical Science in Tshwane District, Gauteng Province, South Africa?” The study was supported by TPACK frameworks.

The study used a qualitative approach. The population of the study was Physical Science teachers who were teaching Grade 12 learners studying Physical Science in four schools in Gauteng Province. These were some of the schools in which MEC Panyaza Lesufi removed all the chalk boards and replaced them with smartboards and where the learners were provided with iPads (Sekhonyane, 2014:1-2).

Semi-structured interviews were applied, guided by a set of questions in the interview protocol, which prompted further discussions with the teachers (Punch & Oancea, 2014:184). A group of 10 learners from Physical Science Grade 12 classes were interviewed through the focus group interview. The researcher of this study observed

Physical Science lessons at the four participating schools. Each class had between 15 and 38 learners per school. Interviews were recorded and observation protocols were used during observations in the classrooms.

Data were analysed inductively using AtlasTI software. Except for the challenges of theft and power failures, teachers had positive experiences teaching with the smartboards. The results showed that teachers can use the smartboard but need to be trained on the pedagogical use of the smartboard so they do not lose a percentage of the learners who are inclined to focus more on the video than the lesson/activity.

Keywords: Smartboard, ICT, Teaching and Learning

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CHAPTER 1 INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

It was reported in the Mail & Guardian (John, 2015) that a Member of the Executive Council, MEC Panayaza Lesufi, had announced that he would replace all chalkboards in Gauteng matric classes with smartboards/interactive whiteboards by July 2015 (Gon, 2015:1). The interactive whiteboard (IWB) or smartboard (SB) is one of the technological items used as part of the ICT integration process (Tűrel & Johnson, 2012:381).

The aim of this chapter is to provide a frame of reference by delineating the present environment for the teaching and learning of Physical Science, primarily emphasising the need for ICT and, in particular, the smartboard in classrooms. According to the South African Government Gazette (2004:16), ICTs can accommodate differences in learning styles and remove barriers to learning by providing expanded opportunities and individualised learning experiences. The researcher was concerned about the influence of these smartboards, as a technological device, on improving the teaching and learning of Grade 12 Physical Science since their installation in 2015. Questions were raised about whether they were interactive, and whether they were enhancing learning.

In South Africa, the results for Physical Science and Mathematics, from Grade 8 to 12, have been below average and this has been a problem for a long time (Department of Basic Education, 2014:24). Dhurumraj (2013:1) and Semeon (2014:2) mention that the reasons for the high failure rate in Physical Science was due to English being the medium of teaching which is usually a second language for most students. This was further exacerbated by the language content of Science, the incompetency of the teachers, as well as the poor attitude to learning Science as a subject (Aktas & Ayedin, 2016:133).

Based on the above factors and the research findings, this study focused on the origin of the smartboard and its purpose in the teaching and learning of Grade 12 Physical Science in the South African context. There is a dearth of research literature in terms of instructional aspects regarding the use of smartboards to guide the teaching and learning of Physical Science.

The aim and objectives of the study are indicated in this chapter. The research problem, research question, research sub-questions and the significance of the study are described, and the research methodology is discussed. A preliminary literature review is included in this chapter. Concepts used in this study are defined together with the outline of the chapters. The conclusion provides a summary of the major ideas discussed in this chapter.

1.2 Background and the rationale for the study

1.2.1 Teaching and learning Physical Science in South African educational contexts

Hardman (2005), points out that there has been a change in the teaching and learning in current laboratories which is evident when compared to the teaching and learning in traditional classrooms. This transformation has presented a shift in education from being teacher-centred, memory-orientated, task-driven classes to an inclusive and integrated practice where learners work collaboratively and engage in meaningful learning (Du Plessis, 2016; Aktas & Aydin, 2016). However, there is little evidence of this shift in research findings in terms of the teaching and learning of Physical Science in South African classrooms (Aktas & Ayedin, 2016).

In traditional classrooms, knowledge has been dispersed by the teacher in front of the classroom and learners have been the receivers of the knowledge. Some learners would memorise everything without understanding just to pass their tests and exams. Learners learned only from tasks given in the form of homework assignments and tests. In an inclusive and integrated practice, learners are given the privilege of sourcing information and using it for learning via different methods or sources of information.

In 2015, the South African Teachers' Union analysed the matric results of the whole country for the period 2012 to 2015 (Department of Basic Education, 2010; 2011). MEC, Maphefo Matsemela (2015) released a statement about these matric results. The results for this period showed that, for Physical Science, 787 fewer candidates wrote the subject than in previous years, 1 443 fewer candidates met the 30% criteria and 1 170 fewer candidates met the 40% criteria. The drop in the 30% and 40% pass rates was a clear indication that special interventions were needed to change the

situation regarding Mathematics and Physical Science which are two of the priority subjects (Matsemela, 2015; Simelane, 2019).

The following table presents the National Senior Certificate Physical Science results from 2008 to 2014. The table indicates the number of learners who wrote Physical Science and the number and percentage of learners who passed the subject.

Table 1.1: National Senior Certificate results from 2008 to 2014 (Physical Science) for all South African Provinces

Year	Number of learners who wrote the exam	Number and percentage of learners who passed the exam
2008	13 612	9 691 (71,2%)
2009	13 347	7 064 (52,9 %)
2010	12 626	7 524 (59,6 %)
2011	180 585	96 441 (53,4) %
2012	182 126	106 661 (61,3%
2013	184 383	124 206 (67,4 %)
2014	167 997	103 348 (61,4 %)

Referring to Table 1.1 above, the number of students who wrote Grade 12 Physical Science increased between 2008 and 2014, but the pass rate did not increase proportionally, with the results showing a decline from 71% to 61.4%. The average pass rate between 2008 and 2014 was 61%.

The statistics show that Physical Science teaching still needs new insight and support in terms of new methods and ICT to improve learning outcomes. According to the SA Government Gazette (2004) and Ramorola (2010:62), ICT can accommodate differences in learning styles and remove barriers to learning by providing expanded opportunities and individualised learning experiences.

1.2.2 The inclusion of smartboards as an ICT device in Physical Science classrooms

Manny-Ikan, Dagan, Tikochiki and Zorman (2011) define the smartboard or interactive whiteboard (IWB) as a technology made up of a computer connected to both a projector and a touch-sensitive board that presents the pictures projected from

the computer, allows for changes and receives input electronically or by touch. The software for the IWBs allows a range of activities, including those that can be used without the use of the IWB (e.g., projecting presentations and short films, writing, and erasing the board), as well as activities unique to this technology (Giles & Shaw, 2011:1).

Mdlongwa (2012:5-6) states that one of the benefits of ICT includes the use of the smartboard in such a way that it promotes teaching and learning in Physical Science classrooms.

The researcher, Fu (2013:113), indicates that the smartboard can increase participation, motivation, augmented collaboration and the improvement of knowledge, as well as research and management skills that make learning and teaching easier and more fun. Physical Science is a practical subject that needs more participation from learners and teachers, and with the smartboard, learning is made easier.

For this purpose, the Government provided some initiatives in terms of the application of ICT in schools. MEC Panyaza Lesufi finalised the ICT strategy by declaring that five schools in Gauteng would be turned into paperless classrooms (Sekhonyane, 2014:12). Teachers would receive tablets, and classrooms would be fitted with interactive whiteboards by 2016. This ICT strategy was finalised in 2015 as 4 000 Grade 12 classrooms in Gauteng Province, South Africa, were fitted with 1 800 smartboards and 17 000 Grade 12 learners were provided with tablets (Sekhonyane, 2014:2; Mchunu, 2016:1).

1.2.3 Rationale for the study

In addition to the above research findings and initiatives, the rationale for this study was derived from the experiences of the researcher of this study, who, as a Physical Science teacher, taught the subject between 2002 and 2011. According to Simelane (2019:25), one of the challenges in teaching Physical Science is the terminology used, such as boiling point, hydrolysis, precipitation, unsaturated compound. For example, the word “precipitation” refers to the solid formed when you mix two liquids.

Another factor is the use of English as the medium of instruction (Viljoen, 2015; Dhurumraj, 2013:1; Semeon, 2014:2) which is a second language for the learners in the townships. Since Physical Science as a subject has theoretical and practical work, it is a challenge to organise practical work due to a large number of learners in each class. In terms of the experience of the researcher, in order to accommodate all learners and to ensure active participation, a one-day activity would take three days. This was time-consuming, as learners had to be divided into three small groups to accommodate them in the laboratory.

In order to perform practical work in the science laboratories, the teacher must explain complex concepts, perform demonstrations and motivate the learners to participate (Kaindume, 2018:6). The challenge is compounded when large classes of 50 to 60 learners are in a laboratory that can only accommodate 20 learners. Kaindume (2013:19) points out that science laboratories do not have all the necessary equipment and some chemicals are hazardous (dangerous and risky for the learners to use but which they are expected to learn about) and, therefore, cannot be used by the learners in high schools. Chemicals, such as sulphuric acid which is found in car batteries, are not safe to be used by learners at high schools. However, they need to know how sulphuric acid transmits an electrical current through the car battery to the engine. Learners can use these types of chemicals in the laboratories at institutions of higher learning as this is where they are preparing themselves for a workplace.

Additionally, motivation for the study was influenced by the advancements in teaching and learning in other countries, such as England and Spain, as well as developing countries, such as Turkey. These countries have invested in interactive whiteboards (smartboards) as the primary technology used for teaching and learning as it increases student motivation, attention, participation and collaboration (Tűrel & Johnson, 2012:281). With the smartboard or interactive whiteboard, learners can interact continuously without the need to be in the physical science laboratory.

This study is primarily aimed at establishing the influence of the use of smartboards in the teaching and learning of Physical Science, since the introduction of smartboards in 2016 in schools in Gauteng, South Africa.

1.3 Research problem

In South Africa, there has been poor performance in Physical Science Grade 12 learners (Viljoen, 2015:5). Smartboards have been introduced as an ICT strategy to improve performance in Physical Science Grade 12 (Sekhonyane, 2015:1; MEC Maphefo Matsemela, 2015:1).

A great deal of research has been done on the use of smartboards in secondary schools in countries such as India, Israel and Turkey (Jena, 2013; Manny-Ikan et al., 2011; Aktas & Aydin, 2016). However, in all of these cited studies, research has not been done on the use of smartboards for teaching Physical Science in Grade 12 classes. Consequently, a gap was identified which required considerable investigation in South African classrooms that had been equipped with smartboards. This problem was investigated through a multiple case study which was conducted to identify learners' and teachers' perceptions in the use of smartboards.

1.4 The aim and objectives of this study

Based on the discussion above, the study aimed to investigate how the use of smartboards influences the teaching and learning of Grade 12 Physical Science in the Tshwane District, Gauteng Province, South Africa. The objectives of the study were:

- To determine how the use of smartboards challenged the teaching and learning of Physical Science for Grade 12.
- To explore the perceptions of teachers who use smartboards for teaching Physical Science.
- To explore the perceptions of learners who learn Physical Science using smartboards.

1.5 Research question and sub-questions

The purpose and the objectives of the research raised the following research question and sub-questions were devised to gain further insight into the problem at hand:

Research Question 1: How does the use of smartboards influence the teaching and learning of Grade 12 Physical Science in the Tshwane District, Gauteng Province, South Africa?

The three sub-questions emanating from Research Question 1 were:

Research Question 1.1: What are the challenges in teaching and learning through the use of smartboards?

Research Question 1.2: What are the Grade 12 Physical Science teachers' perceptions in terms of teaching through the use of smartboards?

Research Question 1.3: What are the Grade 12 Physical Science learners' perceptions in terms of learning through the use of smartboards?

The section below outlines the motivation and the significance of the study.

1.6 Significance of the study

The field of teaching and learning of Physical Science using smartboards has a shared interest in educational environments hence researchers and teachers are affected by and are interested in the appropriate application of smartboards in classrooms.

The research findings on the application of the smartboard and its use in Physical Science classrooms are still relevant because of the increased use of ICT in learning environments (Simon, 2014:3).

ICTs have been embraced in the education sector of SA and there is a very little in the current research literature in terms of instructional aspects regarding the use of smartboards to guide the teaching and learning of Physical Science. This study is important as it illustrates how the smartboards are used for the teaching and learning of Physical Science for Grade 12 within the South African context.

The findings reveal the benefits and challenges of using the smartboards to teach and learn Grade 12 Physical Science. However, the challenges are used as a point of departure to draw recommendations. The findings are drawn from both teachers'

and learners' perceptions of using the smartboards for the teaching and learning of Physical Science.

These finding may also demonstrate how the smartboard can be used for the teaching and learning of other subjects. They could assist the Department of Education to see the gaps that hinder the effective use of ICT, especially the installed smartboard at schools as they expand the projects to other grades. The study will contribute to the body of knowledge through publications.

Many schools in South Africa, as well as globally, are trying to use smartboards in one way or another but teachers are not benefiting from this for multiple reasons (Aktas & Aydin 2016:127; Matsemala, 2015:1). They seem to be lacking guidance on the usage of smartboards. Therefore, there is a definite need to investigate the practical application of smartboards in Physical Science classrooms and to develop some guidelines for the smartboard to be an effective teaching and learning instrument.

1.7 Definition of concepts

Information Communication Technologies (ICT) is a global network in which ideas are exchanged or information and knowledge are shared through using communication tools like cell phones, computers and technology to connect people (Mdlongwa, 2012:1). The ICT tool referred to in this study is the smartboard or interactive whiteboard.

The smartboard (SB), interactive white board (IWB) or electronic whiteboard (EL) is a touch-sensitive screen that works in conjunction with a computer and a projector (Sad, 2012:900). Smartboards use visual learning tools and motivate learner participation.

Teaching is an engagement with learners to enable them to understand and apply knowledge, concepts and processes including designing and selecting the content and its assessment and reflection (Centre for Teaching and Learning, 2013). In this study, teachers were instructing students in Grade 12 Physical Science.

Learning is an active, constructive, cognitive and social process by which the learner strategically manages available cognitive, physical, and social resources to create new knowledge by interacting with information in the environment and integrating it with information already stored in memory (Kozma, 1994:3). Besides, learning is an active process in which people construct new understandings of the world around them through active exploration, experimentation, discussion, and reflection (Kirman, Cornelius, Sachs & Schwab, 2002:33).

The next section outlines the research methodology, population and sampling, data gathering, analysis of data, and the assessment of trustworthiness.

1.8 Research methodology

1.8.1 Research design

The research design applied in this study was a multiple qualitative case study in that the perceptions of learners and teachers in Grade 12 Physical Science classrooms were explored in a bounded context, in naturally occurring phenomena (McMillan & Schumacher, 2010:23; Creswell, 2013:97). In this study, these phenomena were the classrooms in schools that are fitted with smartboards in Grade 12 classes that study Physical Science as a subject. This study used exploratory and descriptive methods, as the teachers' and learners' perceptions were investigated in the specific context of Grade 12 Physical Science classrooms.

1.8.2 Sampling

The population of the study was Physical Science teachers and Grade 12 learners from schools in Gauteng Province where smartboards had been installed and where learners had been provided with iPads (Sekhonyane, 2014:1-2). This study used purposive convenient sampling that entailed the researcher selecting subjects from the population that were informative about the topic of interest (McMillan & Schumacher, 2010:138). Through convenience sampling, a group of subjects were selected (four Grade 12 teachers and 37 learners) from four different schools, based on their accessibility (Kothari, 2004:15).

1.8.3 Data gathering

A multiple case study was used to collect data at four different schools in the Tshwane District of Gauteng Province. Semi-structured individual interviews were applied to collect data from four teachers, guided by a set of questions in keeping with interview protocols, which prompted further discussions (Punch & Oancea, 2014:184). Focus group interviews were conducted with four groups of learners. Each group consisted of between 8–10 learners making up a total of 37. The author of this study observed four Physical Science lessons using observational protocols.

1.8.4 Analysis of data

The ATLAS.ti version 7.5.18 software was used for coding and categorising data. ATLAS.ti is computer software used to facilitate qualitative data storage and analyses (McMillan & Schumacher, 2010:381).

The researcher made observation comments and recorded data from the interviews. Data were analysed inductively by organising it into categories and identifying patterns and relationships among the categories (McMillan & Schumacher, 2010:367). The inductive analysis, as explained by McMillan and Schumacher (2010), involves a systematic process of coding, categorising and interpreting data to explain a single phenomenon. In this study, the phenomenon is teaching and learning using a smartboard.

1.8.5 The assessment of trustworthiness

According to Johnson and Christensen (2012:264), qualitative validity refers to research that is plausible, credible, trustworthy, dependable and confirmable. In this study, triangulation was used to promote trustworthiness (Johnson & Christensen, 2012:266), as multiple data collection methods (individual semi-structured interviews, focus group interviews and observations) were used to study the phenomenon. The researcher took field notes and used observation protocols (see Appendix L) during lesson observations and did not rely on her assumptions to ensure confirmability.

Johnson and Christensen (2012:439) explain triangulation as the term used when the researcher seeks to converge and corroborate results using different methods for the same phenomena. Depending on how different data gathering methods are used and whether the researcher knows how to use different methods, it can increase the

credibility and validity of the research findings (Creswell, 2013:246). In this study, observations and interviews were used to promote the validity of the research.

Researcher bias needed to be considered to avoid it being a threat to the validity of the study. Johnson and Christensen (2012:264) define researcher bias as obtaining results consistent with those which the researcher wants to find and then writing up those results. This, according to Johnson and Christensen (2012:265-266), results from selective observation and allowing personal views and perspectives to affect data interpretation in the study. The researcher of this study was a Physical Science Grade 12 teacher for 13 years, and she was aware that her experience could affect the study, the data collection and analysis. Beyond trustworthiness, ethical principles must be adhered to protect the participants. This is discussed below.

1.8.6 Ethics

Ethical considerations are required as educational research focuses primarily on human beings (McMillan & Schumacher, 2010:14). They protect the rights and welfare of the participants. In this study, ethical clearance was obtained from the University of South Africa through which this study was conducted (see Appendix A).

Participants completed consent forms and the parents of the learners completed an assent form to permit their children to participate in the study. Participants had the right to withdraw from the study if they felt uncomfortable or unwilling to continue with the interviews.

The section below provides an outline of the chapters.

1.9 Outline of chapters

The study consists of the following chapters:

Chapter 1

This chapter focuses on an explanation of ICT and its impact on learning. It presents the smartboard as an improved ICT device for teaching and learning. The chapter also covers the background of the study and the rationale. It presents the aim and objectives of the study, the research question and sub-questions. Additionally, a brief

discussion of the research methodology, ethics and trustworthiness, an outline of the chapters and a conclusion are provided.

Chapter 2

This chapter focuses on the literature regarding the use of smartboards globally, and in South Africa. The focus is on the benefits of ICT for teaching and learning using smartboards. The TPACK theoretical framework that supports the study is discussed in relation to the study in this chapter.

Chapter 3

This chapter focuses on the details of the research methodology used in the study. This includes the research design, population and sampling, data collection methods and the instruments, data analysis, research ethics and trustworthiness.

Chapter 4

This chapter focuses on the analysis of data and the presentation of the results. The biography of the participants is included. The results are derived from the teachers' semi-structured individual interviews, the learners' focus group interviews and observations. Categories were formed and the consolidation of results was comprised. The results are presented using the ATLAS.ti software.

Chapter 5

This chapter gives an overview of the study. It provides a summary of all the chapters. The limitations affecting the study, such as the theft of smartboards during data collection, are discussed. Recommendations emanating from data analysis, such as the pedagogical use of the smartboard, are also presented in the chapter. Ideas for future studies based on the literature review and findings from the study are included in this chapter.

1.10 Conclusion

Chapter 1 outlines the introduction and background of the study, with a brief discussion of the research methodology, research question and sub-questions, data collection methods, data analysis, the significance of the study and an outline of the

chapters. The smartboard or interactive whiteboard, as it is currently known, is one of the assistive technologies used for teaching and learning. Researchers found that the use of the smartboard increases student motivation and engagement in learning (MannyIkan et al., 2011:1). If students are motivated, they will surely learn. The study of smartboards has been carried out, mostly in European countries, for various reasons. In this study, an investigation of the use of smartboards was carried out in South African schools to establish if this produces an improvement in the Grade 12 Physical Science results. The Department of Basic Education in South Africa has invested a significant amount of resources into the smartboard project to create a paperless classroom. Chapter 2 presents the literature review and theoretical framework underpinning the study.

CHAPTER 2 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The previous chapter discussed the problem statement, aims and objectives of the study. It further presented the research questions, research methods and justification of the study. In this chapter, the literature review and the theoretical framework are discussed. Literature depicts that smartboards have been used globally and currently are being used in some South African classrooms. The discussions include the role of ICT in teaching and learning, pedagogical support during the use of smartboards, and the benefits and challenges of using the smartboard in Grade 12 Physical Science classrooms. The study is guided by Technology Pedagogy and Content Knowledge (TPACK) conceptual framework which is discussed in this chapter. The conclusion provides a summary of the crucial ideas in the chapter.

2.2 The framework for teaching and learning Physical Science through the use of smartboards

2.2.1 An overview

It is a well-known fact that many learners find it difficult to understand chemical concepts, such as chemistry, which is a multifaceted discipline requiring complex thinking and reasoning (Kotoka, 2013; Mandina, 2018). This is because physics concepts are abstract (e.g. the concept “momentum” cannot be seen but experienced). The use of visual material can assist in minimising the overloading of short-term memory when learning chemistry (Kotoka, 2013:8). It seems that learners need a technological tool, such as an interactive whiteboard or smartboard that can enhance their understanding of abstract chemical concepts provided it is used appropriately (Kotoka, 2013:8). For example, seeing an abstract concept, such as a volcanic eruption, on the computer or smartboard through the use of a video makes the learning of the concept easier (Du Plessis, 2016). Another example would be learning about the sea or snow. Since some learners have grown up in the interior of the country, they may have no idea of what the sea or snow looks like. They need to see it to understand the magnitude and/or impact of these forces of nature better and

when this happens, learning takes place. The smartboard as a technological tool and its pedagogical nature is discussed in the next section.

2.2.2 What is a smartboard?

The interactive whiteboard (IWB) or smartboard is defined as technology consisting of a computer connected to both a projector and a large touch-sensitive board that presents pictures and is operated through touch (Sad, 2012:900; Tűrel & Johnson 2012:381; Manny-Ikan et al., 2011:1; Al-Faki & Khamis, 2014:137). Al-Faki and Khamis (2014:136) add that users can use their fingers, a special electronic pen (stylus) or a pointer to operate the board and to control computer icons. Tűrel and Johnson (2012:381) state that the interactive whiteboard (IWB) or smartboard (SB) is one of the technological items used as part of the ICT integration process.

Many people call it a smartboard because SMART Technologies Company was a pioneer provider to the educational sector (Al-Faki & Khamis, 2014:138). According to Al-Faki and Khamis (2014:138), the first smartboard was introduced in 1991 and was used in business presentations. In schools, in the Gauteng Province in South Africa, smartboards or LED interactive whiteboards are used in conjunction with the tablets that learners use as textbooks or working books (Gon, 2015:1). The interactive whiteboards are fitted with world-class teaching software and are fully integrated with the learners' tablets for easy interaction during lesson delivery. These smartboards were installed to replace the chalk boards.

Because the goal of this study was to investigate the influence of the smartboard as an ICT device in the teaching and learning of Grade 12 Physical Science, it is necessary to discuss the role of ICT in classrooms in more detail.

2.2.3 The integration of ICT in classrooms and its role in teaching and learning

In South Africa, the Department of Basic Education set out the integration of ICT into schools as a way of providing quality education to learners and teachers (Dzani & Amadzo, 2014:347). The integration of ICT into schools is supported by the research findings of Molotsi (2014:14), Fu (2013:113) and Mdlongwa (2012:5) who highlight that ICT produces quality teaching and learning. Mwalomgo (2011:36), Mandina (2018:20) and Adeyemo (2010:36) agree that the integration of ICT in education promotes autonomous learning, high-order thinking, problem-solving skills,

cooperative learning, clarification of abstract concepts and transformation. This can be done through encouraging innovative online activities (e.g. Q&A eLearning blogs, Physical Science interactive tutorials, videos, podcasts). In this way, learners become creators of knowledge through, for example, researching a school project using the internet rather than only their textbooks (Mdlongwa, 2012:4). They can also work together in a group collaboratively to complete a given task.

Furthermore, ICT allows teachers to minimise the use of the "36 and talk" method and students can acquire knowledge on their own through projects and problem-solving activities (Mandina, 2018:24). Therefore, ICT is changing the way students learn and teachers teach (Dzansi & Amadzo, 2014:341).

Moreover, researcher Adeyemo (2010:51) states that most of the educational experts agree in terms of the need to use ICT in classrooms in an appropriate way. One of the ways is to use ICT as a stimulus for learning that may inspire learners to repeat experiments which, in turn, aids the understanding of science concepts (Adeyemo, 2010:52). However, there are no widely accepted methods for teaching Physical Science through ICT.

2.2.4 The use of the smartboard in Physical Science classrooms

The smartboard is an ICT device that is connected to the internet through which learners can do research and be innovative. Thus, the smartboard as an ICT device is expected to improve teaching and learning in Physical Science classrooms, provided that it is used adequately and that the teacher has acquired the appropriate training (Mashaba, 2016:1).

Mwalongo (2011:45) argues that when lessons are properly prepared to ensure that learning occurs, ICT will impact the students' learning by promoting innovation through engaging their cognitive potential (Balta & Duran, 2015:15). Mwalongo (2011:45) further states that suitable use of the smartboard makes it easier for the student to understand the subject matter through the use of different perspectives. For example, when using the smartboard learners can visualise different earth layers leading to the volcanic eruption, rather than just imagining it.

Thus, the smartboard as an ICT device can simplify the students' understanding of different abstract concepts and makes them more actively involved with the subject. Learners, for example, can see the galaxy through a video on the smartboard rather than trying to imagine it. Learners can do activities with an immediate response when using the smartboard as an ICT device. This can free up the teacher's time to concentrate on learners' participation and the facilitation of the Physical Science lesson.

However, it is not yet clear how to use the smartboards appropriately to improve teaching and encourage learners' critical thinking and innovation which are paramount in educational environments. When using the smartboard, the teachers need to present snapshots of YouTube videos with explanations rather than only presenting one long video at a time. This means that teachers still need to do in-depth research when planning their lessons to be effective in teaching and learning while using the smartboard.

ICT skills or smartboard training are not the only requirements for effective teaching and learning when using this type of technology. Pedagogy is equally very important because as observed in the current teaching, without pedagogy and training, the use of ICT can be frustrating.

Research has been done on the teaching and learning of science, its challenges and barriers related to poor performance in South Africa (Kaindume, 2018; Simelane, 2019; Mandina, 2018). A great deal of research has also been done on the use of the smartboard in secondary schools in developed and developing countries, such as India, Turkey, Spain, the UK and Israel (Jena, 2013; Manny-Ikan et al., 2011; Aktas & Aydin, 2016). However, not much research has been done on the effective use of the smartboard for teaching and learning Grade 12 Physical Science. Consequently, a gap was identified which requires considerable investigation in classrooms that are equipped with the smartboards in Gauteng schools. In the next section, the role of pedagogy when implementing the smartboard is presented.

2.2.5 Pedagogical support for the implementation of the smartboard

The SA Government Gazette (2004) states that ICT needs to be introduced into schools to extend and improve education across the curriculum and in terms of pedagogy. Teachers do not only need training in computer literacy but also in pedagogical applications of those skills to improve teaching through the use of the smartboards as an ICT device (Al-Faki & Khamis, 2014:139). The authors specify that teachers, who use smartboards, are no longer dispersers of knowledge but the facilitators and guiders of the learners' learning to ensure the achievement of learning outcomes. Teachers can explain difficult concepts through demonstrations and ensure the use of the correct online material. An example of this is NASA Education, found on the Mashable website, which has prepared interactive lessons.

Technical and pedagogical support plays an important role in implementing the smartboard in teaching and learning (Al-Faki & Khamis, 2014:139). This point is highlighted by Bindu (2016:250) who argues that ICT utilisation facilitates the learner-centred approach rather than a conventional teacher-centred approach.

When teaching, the focus must be on the learners and their participation and interaction with the learning content. This is achieved by denoting ICT as cognitive tools. Computers are referred to as cognitive tools that use technology with which learners interact, which encourage knowledge construction, and which are designed to bring their expertise to the performance as part of the joint learning system (College of Education, 2014:9). Students do not learn directly from technology; the role of technology is to engage the learner more actively in the process of thinking and manipulating information which, in turn, facilitates the learning process. This is achieved through learners' participation in small group online discussions, watching YouTube Physical Science videos, contributing to Physical Science online blogs and participating in Q&A eLearning classrooms.

The smartboard in this study is the cognitive tool because it possesses visual features that assist learners to understand and remember concepts learned under the pedagogical guidance of the teacher. The College of Education Report (2014) also cautions that, although students enter into intellectual partnerships with the tools, the role of technology as a cognitive tool is not meant to think for learners, but only to facilitate the thinking and learning processes.

Thus, technology alone is not enough, and teachers must have an appropriate technique or method of teaching using a technology device such as the smartboard. For example, a teacher can play a YouTube video but must meet a certain outcome of the lesson which demands good planning rather than playing it for entertainment.

This pedagogical approach is enriched with guidelines proposed by Gonzalez (2014:1-2), namely, the use of the smartboard as one of the tools for learning; motivating the students to use it; using it for presentations, word processing, news articles, experiments; and evaluating which features are not relevant to the teaching and learning of science. Schuck and Kearney (2007:12-13) also agree and highlight features of the pedagogy approach that the teacher must consider when teaching with the interactive whiteboard, namely, the attitude of the teachers and how much they are willing to embed in this technology; and planning and preparation of compulsory activities that encourage a thinking approach. For this purpose, the teachers can draw on a wide range of web-based subject-specific resources and integrate ICT into their lessons to harness a full potential digital approach.

The researcher assumed that the selected teachers in this study, who were using the smartboard for teaching, had received ICT training and pedagogical training on how to encourage learners to develop a positive learning experience.

2.2.6 Challenges of using the smartboard

Due to multiple ICT benefits, Tanzania has encouraged teachers to integrate ICT in education at various levels (Mwalongo, 2011:36). However, globally and in South Africa, though ICT has beneficial implications for both teachers and learners, it has several challenges (Mdlongwa, 2012:4). Sekhonyane (2014:2) revealed the problem of the theft of tablets in Gauteng schools as one of the obstacles in integrating ICT in educational contexts. The theft of tablets makes it impossible for learners to engage with technology as they need to use electronic workbooks loaded on the tablets.

Matwadia (2018:154) cited low connectivity and the lack of teacher training as two of the challenges that affect the use of the smartboards. Low connectivity affects effective teaching and learning as some software cannot operate without stable internet connectivity. According to Gon (2015), unlike textbooks, tablets need to be

constantly upgraded with new apps, software and security, as well as operating systems. This is due to rapid developments in technology.

There are also other technical challenges that teachers may face when using the smartboard. The challenges include running out of electric pen, the updating of computer programs and files not being compatible with the interactive whiteboard (Al-Faki & Khamis, 2014:139). If a teacher does not know how to do this or is not trained to address the technical challenges, it may affect the teacher's confidence and delay the preparation of lessons. Moreover, most teachers are not ICT specialists and they need technical support to ensure lesson continuity. In this study, these challenges were considered, and teachers checked the smartboard before the lessons in terms of technical concerns, software upgrades and security issues. Technical challenges can be rectified through ICT training and the provision of professional technicians to support the schools.

Competency in the subject gives the teacher confidence and the ability to identify the learners' needs and how to use the technology to bridge the identified gaps. Kimathi and Rusznyak (2018:12) support the need for teachers to be competent in the subject they teach. UKEssays (2015) indicate that some teachers present work copied from the internet and they do not provide examples or expand on the information. This approach can encourage learners to adopt the same method of copying information and discontinue their work. Other students may be distracted and focus on social media during lessons. Thus, research findings indicate the need for the pedagogical and technical training of teachers to handle the above challenges and adequately support Physical Science teaching and learning.

The theoretical framework, Technology, Pedagogy and Content Knowledge (TPACK) that underpins this study is discussed in the next section.

2.3 TPACK – The theoretical framework used as a basis for teaching and learning with the smartboard

The theoretical framework that is underpinning the study is the Technology, Pedagogy and Content Knowledge (TPACK) framework. Mishra and Koehler (2006:1020) based their TPACK framework on the fact that teaching has become a

complex activity that draws on many kinds of knowledge. TPACK consists of three components, namely, technology, pedagogy and content. Figure 2.1 below presents the TPACK framework underpinning the study.

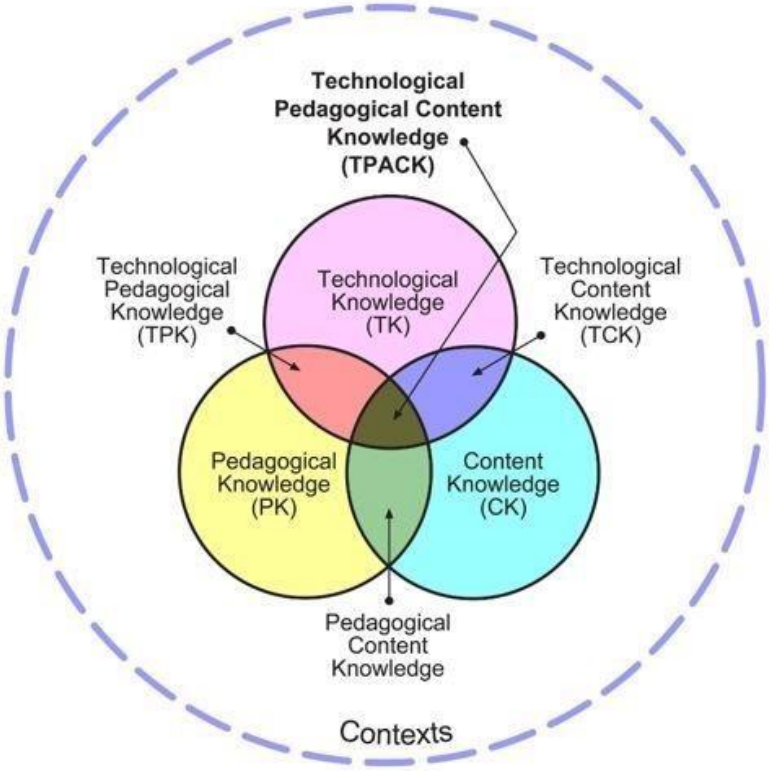

Figure 2.1: The TPACK framework and its knowledge components
(Source: Mishra & Koehler, 2006)

The three components of the TPACK framework (technology, pedagogy and content) are interrelated as illustrated in Figure 2.1 above. These components are integrated where the circles overlap as shown.

Technological knowledge (TK) is knowing the devices, such as videos, the internet and the books that teachers use and having the skills to use them (Mishra & Koehler, 2006:1028). Smartboard training was offered by the Department of Basic Education after the installation of the smartboards. It is essential for teachers to be aware of the fictional components of the technology that they use or is available to them so they can use it maximally to enhance their teaching. However, it may not be true that all teachers are competent with the technology they use. Mdlongwa (2012:3) agrees that

Gauteng schools have 88,5% of computers but only 45% of teachers are using them for teaching and learning. The provision of technological devices to schools does not guarantee usage. There may be reasons for this non-usage that needs to be investigated further in another study.

From the literature review (2.2.4), the researcher endorses that all teachers in Gauteng schools, where smartboards had been installed, received training on the use of the smartboard and the technological aspects of it. However, research on the instructional uses of technology revealed that teachers often lack the knowledge to integrate technology successfully in their teaching and their attempts tend to be limited in scope, variety, and depth (Koehler et al., 2013:103).

Thus, technology is used more as "efficiency aids and extension devices" (McCormick & Scrimshaw, 2001:31) rather than as tools that can "transform the nature of a subject at the most fundamental level" (Koehler et al., 2013:47). In this study, the researcher noted that the smartboards are used to enhance Physical Science content knowledge; for example, they are used as a tool to project notes rather than these being written on the board. However, the teacher can use the smartboard to design mind maps with visual attachments that attract the learners' attention.

Before the teacher uses technology, he or she must have adequate knowledge about the Physical Science content and the pedagogical method (e.g. feedback, questions and answers, small group discussions) to present the content and must be able to use the technology to deliver the lesson to ensure that there is teaching and learning.

According to Mishra and Koehler (2006:1026), *content knowledge* (CK) refers to the Grade 12 Physical Science content, the subject that needs to be taught in Grade 12 for the current year of study. Teachers must have full knowledge of the content of Grade 12 Physical Science and should be qualified by the higher educational institutions they attended to be able to teach it (CK). Teachers are expected to have acquired this knowledge from their in-service training as teachers at higher educational institutions (Kimathi & Rusznyak, 2018:3). For teachers to be appointed to teach Physical Science, it must have been included as a module in their higher educational qualification.

Pedagogical knowledge (PK) encompasses the processes and procedures or methods of teaching and learning inclusive of classroom management, lesson plan development with aims, objectives and the evaluation or assessment of learners. These methods are included in the way teachers use the smartboard for teaching and learning. One of the sub-questions in this study focused on how this technology (smartboard) was used for teaching and learning. The smartboards installed in Gauteng schools, with all their features, will not benefit teachers and learners unless adequate training and pedagogical training is made available to both teachers and learners.

Furthermore, Mishra and Koehler (2006) explain that technology, pedagogical knowledge and content knowledge are an emergent form of knowledge that goes beyond the three components (see Figure 2.1). Therefore, Technological Pedagogical Content Knowledge (TPACK) refers to a synergy between technology, pedagogy, and content knowledge that enables teachers to develop appropriate and context-specific teaching strategies that can enhance teaching and learning and improve learners' performance (Koehler, Mishra, Kereluik, Seob Shin & Graham, 2013:103). Although the smartboards and tablets were introduced to respond to the 4th industrial revolution and to enhance the learners' performance, it is very important to connect the tree components for effective teaching and learning. Thus, teaching and learning in Physical Science classrooms require a multifaceted relationship between technology, pedagogy and content knowledge.

The TPACK framework is, therefore, applicable for teaching and learning in Physical Science classrooms because it highlights the relationship between three crucial elements (technology, content and pedagogy) that reflects a similar relationship between Physical Science content knowledge, the smartboard as the technology device and the pedagogical knowledge necessary to present the content to learners.

2.4 Conclusion

This chapter focused on the literature review leading to the theoretical framework for the teaching and learning of Physical Science using ICT, especially, the smartboard. The literature revealed the importance of smartboards, globally and locally, inclusive of the benefits and challenges. The study was viewed through the TPACK framework

because it encourages the use of technology for teaching, as well as the content knowledge and the pedagogy necessary for presenting the lessons. The next chapter outlines the research methodology.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter presented the literature review for teaching and learning Physical Science through the use of smartboards. This chapter focuses on the research methodology used for this study. The chapter begins with a recap of the research objectives. It examines the philosophical assumptions underlying the research, as well as the research design, data collection methods, data analysis and the measures taken to ensure trustworthiness. The chapter also shows how the sample size was arrived at and the sampling technique used, then concludes with the ethical considerations to the study.

3.2 Purpose of the research and research objectives

As presented in Chapter 1, the main aim of the research was to investigate how the use of the smartboard influences the teaching and learning of Grade 12 Physical Science in the Tshwane District, Gauteng Province, South Africa. To achieve the main objective of the research study, the following specific objectives were formulated:

- To determine how the use of smartboards challenged the teaching and learning of Physical Science for Grade 12;
- To explore the perceptions of teachers who are using the smartboard for teaching Physical Science;
- To explore the perceptions of learners who learn Physical Science using the smartboard.

3.3 Methodological framework

According to Kothari (2004:8), research methodology is a way to systematically solve the research problem, while research methods include methods and/or techniques that are used for conducting research.

3.3.1 Philosophical assumptions underlying the research

According to Phothongsunan (2010:1), an interpretive paradigm focuses on the social world that is constructed by human beings. The goal of an interpretive paradigm is to understand the meanings people give to objects, events in the environment and human behaviour (Bryman, 2012). In this paradigm, the researcher is a meaning maker who interprets classroom events and the behaviour of participants. Thomas (2010:926) stresses that an interpretive paradigm is concerned with understanding the world as it is from the subjective experiences of individuals (the learners and the teachers). In this study, teachers and learners were interviewed and observed to understand their experiences with the smartboard.

The interpretive researcher uses a qualitative method to collect and analyse data by studying a small number of participants (Phothongsunan, 2010:2). Furthermore, Phothongsunan (2010:3) explains that one of the tools used in interpretive research is interviews and questionnaires. Since this is a qualitative research study, interviews and observations were used as the methods to collect data. Thus, the interpretive paradigm is appropriate for this study, because it supports the examination of teaching and learning, classroom management, lesson presentation, observation of behaviour and evaluation or assessment.

The interpretive paradigm, with its emphasis on understanding the world from the subjective experiences of teachers and students, encompasses the TPACK framework, as the focus is on the understanding of perceptions and human behaviour in the environment, and the perceptions of learners and teachers, taking into account the relationship between the three elements of TPACK, namely technology, pedagogy and content. In the next section, the researcher explains the methods used to collect data from the participants.

3.3.2 Qualitative research design

Based on the TPACK framework and the interpretive paradigm, the qualitative research design was derived. A research design describes the procedures for conducting a study including when, from where, and under what conditions data can be obtained (McMillan & Schumacher, 2010:28). In this study, the researcher follows the procedure for the qualitative research design based on the interpretive paradigm and the TPACK framework.

The research design applied in this study was qualitative and a multiple qualitative case study in that the experience of learners and teachers in Physical Science classrooms was explored in a bounded context, namely, four high schools. A qualitative research approach assists researchers in understanding and exploring a central phenomenon in an attempt to describe and interpret a human phenomenon, often in the words of the informants (McMillan & Schumacher, 2010:23; Creswell, 2013:14). It entails a naturalistic inquiry and data collection strategies to determine the natural flow of events and processes and the subjects' beliefs, thoughts and perceptions (Creswell, 2013:44) that are applicable in a specific setting, in this case, Physical Science classrooms. The non-participant method (Kothari, 2004:98) was applied as the researcher of this study was not a facilitator but only an observer of the Physical Science lessons being presented using the smartboard.

3.3.2.1 Multiple Case study design

In this study, a multiple case study design was used. According to McMillan and Schumacher (2010:344) and Creswell (2014:14), a case study is an in-depth study of a single entity. The single entity that is being studied is a high school. Since this study researched more than one school, a multiple case study was appropriate. With a multiple case study, more than one example or setting is used (McMillan & Schumacher, 2010:345), as is the case with this study, where four schools were studied. The purpose of a multiple case study is to replicate the findings and to be able to predict similar results or contracting results (Baxter & Jack, 2008:548).

This study examined four schools that use a smartboard for teaching and learning. Furthermore, the researcher used semi-structured individual interviews, observation and focus groups to answer the "how" and "why" questions. Moreover, the behaviour of the learners was not manipulated as the research was conducted by a non-participant observer.

3.4 Research population and sampling

The population of the study is the Physical Science teachers teaching Grade 12 and Grade 12 learners studying Physical Science from four schools in Gauteng Province. These are schools where the chalkboards were replaced with smartboards (interactive whiteboards) and where learners were provided with tablets (Sekhonyane, 2014:1).

The sample consisted of four Grade 12 Physical Science teachers teaching Physical Science to Grade 12 Physical Science learners. The study was conducted in Grade 12 Physical Science classes as smartboards had been installed in these classrooms during 2016 (Sekhonyane, 2015:1).

This study used the purposeful sampling strategy, in which participants were intentionally or purposefully chosen for this research (McMillian & Schumacher, 2010:138). Furthermore, convenient sampling was applied in this study as the researcher chose the sample based on predefined criteria and convenience in terms of the time and facilities available.

The criteria used for convenience sampling were that the teacher must be trained in terms of the smartboard, the participating learners needed to be computer literate, the schools had to be equipped with smartboards and needed to be in close vicinity to each other due to travel issues, and the teachers must have had at least one year of teaching with the smartboard. Furthermore, the criteria used for convenience sampling included the accessibility of the participants and their level of computer literacy (McMillian & Schumacher, 2010:151). The teachers selected had different experiences in using the smartboard that ranged from between one year and three years. The next section presents interventions and the setting in more detail.

3.4.1 Biography: The population and sample

The data for this study were collected from the four schools in the Tshwane District that were given smartboards by the Gauteng Department of Education. Three of the schools (Schools A, B and C) are situated within the same perimeter but on opposite sides of the area, whereas the fourth school (School D) is situated approximately 20km from the other schools.

Table 3.1 below presents the biography of the teachers-participants.

Table 3.1 Biographical information: The Grade 12 teachers

Schools	Areas	Years of teaching experience	Gender
A	Atteridgeville, west of Pretoria	3 years	Female
B	Saulsville, west of Pretoria	4 years	Male
C	Saulsville, west of Pretoria	3 years	Female
D	Heuweloord, a suburb of Centurion, located between Pretoria and Midrand	11 years	Male

The table above presents the biographical information of the population and sample, which includes two female teachers and two male teachers with varying years of teaching experience.

3.5 Interventions and the setting

The researcher sent a letter to the Grade 12 Physical Science teachers, who accepted the proposed research, and they informed the pupils, outlining the benefits of the research study and the researcher's role in the classroom. According to the brief given to the learners at the commencement of the Physical Science lessons, they had to carry out their classroom tasks under the guidance of the teacher who presented the lesson with the smartboard (see Appendix C). Thus, the learners were made aware of the value, in terms of this research study, to encourage participation in the classroom lessons and to empower their spirit for learning Physical Science through an ICT device, namely, the smartboard.

The learners and the teachers used the smartboard as a technological form of communication. The teachers used the smartboard to present the Physical Science

lessons with demonstrations, questions and technical discussions as the methods of instruction. These discussions included how to conceptualise various Physical Science concepts with the visual presentation provided by the smartboard. The learners worked on different tasks and exchanged Physical Science ideas specific to the lesson. The learners committed themselves to actively engage in classroom activities (e.g. discussions, problem-based learning, brainstorming) and, at the end of the lesson, this helped to determine their perceptions of working with the smartboard. These lessons were facilitated by the teachers, who led the discussions and guided the exchange of ideas between the learners.

The learning and the teaching aspects of the smartboard application were, therefore, critical, with the focus topic of this research being the perceptions of teachers and learners in terms of smartboard usage and its benefits.

3.6 Data collection methods

Data were collected through observations, semi-structured interviews and focus groups. Individual semi-structured interviews were used to collect data from teachers who teach Physical Science and from focus groups of Grade 12 learners doing Physical Science as a subject.

Methodological triangulation was applied through three data-gathering methods, namely, observations, individual semi-structured interviews with teachers and focus group interviews with learners. Johnson and Christensen (2012:439) explain triangulation as the term used when the researcher seeks to converge and corroborate results using different methods for the same phenomena as this increases the credibility and validity of the research findings.

The researcher used the observation protocol with pre-identified criteria (see Appendix L). An observational protocol has a rubric for observational comments that includes the events and the learners' and teachers' perceptions regarding the use of the smartboard. The researcher recorded observational comments during the process of observation and immediately after the lesson. Class activities, interactions, communications between learners and the teacher and communications between learners were observed and recorded to collect detailed views from the participants.

The researcher also developed the individual and the focus group interview protocols (see Appendix H).

The teachers from each identified school were interviewed face-to-face and the learners as a focus group. The researcher decided to interview the teachers face-to-face because it was difficult to organise a session with all four teachers due to the lack of time and travelling inconveniences. Also, the teachers had different class schedules and it would have been an additional burden for them. The interviews with the teachers took place before the lesson observations and the learners were interviewed after lessons. Interviews were voluntary. All participants completed the consent forms (Appendices C and F). Parental approval was sought from the parents before interviewing the learners (see Appendix G).

3.6.1 Semi-structured individual interviews

The researcher followed the guidelines from Punch and Oancea (2014:182), who point out that an interview is a data collection method used to explore people's perceptions, meanings, their definition of situations and their construction of reality. These individual interviews were aimed at uncovering the teachers' perceptions of smartboards and the impact they had on teaching. The researcher followed the interview protocols by establishing a rapport with the participants and setting open-ended questions that were specific to the study (McMillian & Schumacher, 2010:206). Thus, semi-structured individual interviews were used with the teacher-participants, guided by a set of probing questions (Punch & Oancea, 2014:184). A tape recorder was used to record the interviews and the data was transcribed verbatim. Each interview was limited to plus/minus 45 minutes per participant, depending on the timetable of the specific school under study. The following table presents the sample of teachers that were interviewed at each school.

Table 3.2: Summary of teacher-participants per school

Teacher Participants		Schools
1 teacher	3 years	School A
1 teacher	3 years	School B
1 teacher	3 years	School C
1 teacher	11 years	School D

The table above indicates the number of teachers that were interviewed at each school. Each teacher taught Grade 12 Physical Science.

The researcher informed teachers and learners through personal contact and followed up telephonically.

3.6.2 Observations

According to Angrosino (2014:166), observation is used to investigate the extent to which technology is used in the classroom. The same data collection method was used to collect data in the Grade 12 Physical Science classes, where the teacher used the smartboard to facilitate teaching and learning. The learners engaged with the content during the lesson.

Johnson and Christensen (2012:207) suggest that qualitative observation is usually done for exploratory purposes in natural settings. The natural settings in this study were the schools with classrooms that had been fitted with smartboards in the Tshwane District of Gauteng Province. Learners were observed as they participated during the Physical Science lesson being presented with the use of the smartboard. The teachers were observed as they interacted with the learners and presented the lesson content while using the smartboard.

An arrangement was made with specific class teachers for data collection. The teachers chose the topic to be presented dependent on his/her schedule for that specific day. The researcher observed the participant teachers' and learners' technological skills and how this facilitated learning. Field notes were recorded during and after the observations (Johnson & Christensen, 2012:209).

The observation was confined to one lesson of Physical Science per class for 30 minutes or 40 minutes, depending on the schedule of each identified school. The researcher used an observation protocol tool to record data (see Appendix L) and also took notes. Nonverbal responses were observed and noted when lessons were presented using the smartboard.

3.6.3 Focus group interviews

The focus group interviews were semi-structured and organised after each observation session. The Grade 12 learners from each selected school were interviewed as a focus group. There were four focus groups of learners in total. Each group had eight to ten participants which depended on their availability per school, with characteristics related to the purpose of the research. There was one focus group interview per class per selected school.

Data were captured using a voice recorder. Using the recorder ensured completeness of the verbal interaction and provided material for reliability checks (McMillan & Schumacher, 2010:360). This also applies to how using audiotapes to record questions and responses during interviews give an accurate record of the conversation. The recordings were transcribed verbatim and analysed immediately after data gathering. In addition, the recordings were stored electronically. The following Table 3.3 presents the sample of learners who were interviewed from each school.

Table 3.3: Summary of learner participants per school

Learner Participants per Focus Group	Schools
10 learners	School A
10 learners	School B
8 learners	School C
9 learners	School D

The researcher reminded teachers about the learners' obligation to attend the focus group interview on the day after the last Physical Science lesson. The Physical Science classroom was the most convenient place for pupils to gather together. This

was to avoid disturbing other classes that did not participate in the research. The interviews were completed without any further obstacles.

Each interview was limited to plus/minus 45 minutes per group of learners, depending on the timetable of the specific school under study. The researcher organised the time and the place of the group focus interviews at each of the participating schools.

3.7 Data analysis technique

A large amount of data was collected using individual interviews, focus groups and observation. It was analysed qualitatively, summarised and interpreted (McMillian & Schumacher, 2010:367).

Interview data were transcribed and analysed inductively by identifying patterns and relationships and organising them into categories. The inductive analysis involved a systematic process of coding, categorising and interpreting data to provide an explanation for a single phenomenon.

The data were analysed using the ATLAS.ti program version 7.5.18 (see Appendix M). There was a need for a manual derivation of the categories and a comparison between the individual interviews, the focus group interviews and the observational data in terms of common themes and patterns.

The perceptions of learners and teachers were evaluated and compared within and between the individual and the focus group interviews. For this purpose, the researcher used a colour coding scheme on the observational notes and interview transcripts. The observational data and interview data were compared, and common patterns and themes were identified that influenced a derivation of categories (see Appendix M) to answer the research questions of the study. The triangulation method was used to compare data between interviews (Creswell & Miller, 2000:126).

The data gathering methods and analysis of data were validated through the assessment of trustworthiness.

3.8 Assessment of trustworthiness

According to Johnson and Christensen (2012:264), qualitative validity refers to research that is plausible, credible, trustworthy, dependable and confirmable. The results from the three data gathering instruments were compared to determine the consistency and reliability of the findings. Triangulation is a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study (Creswell & Miller, 2000:126). The main purpose is to enhance the accuracy of the study, Creswell (2012:259), Golafshani (2003:609) and De Vos et al. (2005:361) describe data triangulation as the use of more than one data source in a study. In this study, two data sources were used, namely teachers and learners.

Furthermore, Johnson and Christensen (2012:439) explain triangulation as the term used when the researcher seeks to converge results using different methods for the same phenomena as this increases the credibility and validity of the research findings. It is used by researchers as a lens through which data is sorted to find common themes and for eliminating overlapping areas (Creswell & Miller, 2000:127).

Reliability refers to the accuracy of an instrument and the extent to which a research study produces consistent results in the same settings. Triangulation is the process of corroborating evidence from different individuals or methods of data collection in descriptions and themes for qualitative research. In this study, different data gathering methods, which included observation, semi-structured individual interviews and focus groups, were used to promote the validity of the research. Furthermore, in this study, interviews, a focus group and observations were used to collect data from four different schools to promote trustworthiness (Johnson & Christensen, 2012:266). All three methods were used to achieve methodological and data triangulation to look for convergence among different sources of data and different methods of data gathering to answer the research questions in this study. The research phenomenon was embedded in the theoretical framework, TPACK, and supported by an interpretive paradigm that could contribute to the internal and external validity of this study.

Researcher bias is a threat to validity. Johnson and Christensen (2012:264) define this as obtaining results consistent with what the researcher wants to find. This,

according to Johnson and Christensen (2012:265-266), results from selective observation and by allowing personal views and perspectives to affect data interpretation and the study. The researcher, as a former Grade 12 Physical Science teacher, had to ensure that her experience did not lead to research bias and that it did not affect the study, the data collection or the analysis thereof. Trustworthiness in this qualitative research was achieved through credibility, transferability, dependability and confirmability. These methods that ensured the validity and trustworthiness of data collected in this study are explained in more detail below.

3.8.1 Credibility

Shenton (2004:64) states that internal validity is used to guarantee that the research methods produce the correct findings. He also states that one of the provisions that researchers can use to ensure accurate recordings for phenomena under scrutiny is the development of an early familiarity with the culture of the participating organisation before the first data collection dialogues take place. In this study, the researcher visited the schools first and engaged with the principals and selected teachers. Consent forms were given to the participating teachers. The researcher explained the process required for data collection.

Shenton (2004:65) and Creswell and Miller (2000:126) further state that credibility can be achieved through triangulation where different methods are used to collect data. In this study, data were collected using semi-structured interviews, observation of the Physical Science Grade 12 lessons using the smartboard and focus group interviews with open-ended questions.

Moreover, Shenton (2004:66) highlights that internal validity can be achieved through "tactics that can help to ensure honesty in informants when contributing data". In this study, participants were informed that they could withdraw at any time to ensure that only honest and bona fide participants participated in the study. To ensure this credibility, teacher participants signed a consent form. The Grade 12 learners also signed a consent form and their parents signed an assent form.

Frequent debriefing sessions between the researcher and his/her superior can enhance internal validity. Through discussions, the vision of the researcher may be

widened through the experiences of others. The researcher in this study had constant engagements with her supervisor who contributed to the study.

3.8.2 Dependability

Dependability is the process of data collection using the same methods with the same participants (Shenton, 2004:71). This was achieved through “overlapping methods” which included the focus group interviews and individual interviews. In this study, interviews were used to collect data from the Grade 12 Physical Science teachers and from the focus groups of Grade 12 learners from four schools that have smartboards installed. The purpose was to corroborate the results or findings.

3.8.3 Confirmability

Shenton (2004:72) explains that confirmability is used to remove the researcher’s biases and ensures objectivity through triangulation. For this study, triangulation was used for confirmability. Two sources of data (teachers and learners) and three different methods were used to ensure that the findings were the participants’ perceptions and not those of the researcher. The researcher took field notes and did not rely on her assumptions to ensure confirmability. As explained previously, triangulation is when a researcher uses different methods to collect data to ensure reliability. In this study, data were collected using observation, semi-structured interviews and focus group interviews.

3.8.4 Transferability

Transferability is the extent to which the findings of one study can be applied to other studies (Shenton, 2004:69; Molotsi, 2014:99). Information gathered can be referenced to other studies but is not necessarily applicable to this study. Since the findings of a qualitative project are specific to a small number of particular environments and individuals, it is impossible to demonstrate that the findings and conclusions apply to other situations and populations (Shenton, 2004:70). In this study, a qualitative approach was used for the data collection from only four schools in the Gauteng Province. The focus was on Physical Science taught to Grade 12 students using a smartboard. The findings can be referenced, but not necessarily transferred to other studies. Research ethics are discussed in the next section to explain the ethical considerations when collecting data.

3.9 Research ethics

According to Johnson and Christensen (2012:99), ethics are principles and guidelines that help us to uphold the things that we value. In this study, participants (both teachers and learners) completed consent forms and the parents of the learners completed an assent form permitting their children to participate in the study. Participants had the right to withdraw from the study if they felt uncomfortable or unwilling to continue with the interviews.

Ethical considerations are required as educational research focuses primarily on human beings (McMillan & Schumacher, 2010:14). It protects the rights and welfare of the participants. In this case, ethical clearance was obtained from the University of South Africa through which this study was conducted.

Permission to collect data was requested from the UNISA Ethics Committee in the College of Education and also from the Gauteng Department of Education (see Appendix B) for the Tshwane District of Gauteng Province. Once approved, the approval letter was submitted to the identified schools to request permission to have access to the schools. The principals of the identified schools were sent letters requesting permission to access the schools (Appendix D) and gave permission for the teachers to be interviewed and for the focus group interviews, as well as permission to observe a Physical Science lesson, delivered using a smartboard.

The participants signed consent forms (Appendix C) and the consent return slip (Appendix E) and the parents of the learners participating in the study signed an assent form (Appendix F). The informed consent form was based on the information provided by the researcher for the participants to agree to be part of the study (Molotsi, 2014:84).

3.10 Conclusion

This chapter focuses on the research methodology which included the purpose of the study, the research paradigm, qualitative research design, data collection and analysis, assessment of trustworthiness, and the ethical considerations of the research.

Furthermore, this chapter explains how the participants were sampled. The data collection method used for this study was outlined. This chapter highlights how the data analysis was carried out and the measures used to ensure the trustworthiness of the research. The next chapter presents information on the data collected and the findings after analysis.

CHAPTER 4 ANALYSIS, INTERPRETATION AND DISCUSSION OF RESULTS

4.1 Introduction

The previous chapter discussed the research methods used in this study. These included the research design, data collection methods, population and sampling, data analysis, research ethics and methods ensuring the trustworthiness of the study. The purpose of this chapter is to present the research results based on both the teachers' and learners' perceptions of using the smartboard for the teaching and learning of Grade 12 Physical Science. A multiple case study design was followed for this study (see section 3.4.1.1). The methods used to gather and analyse data were discussed in sections 3.4.2 and 3.7 respectively.

4.1.1 Background

For confidentiality, the schools where data were collected have been identified as School A, B, C and D. Permission was obtained from the Gauteng Province Department of Education (Appendix B) before accessing the schools.

An ethics certificate (Appendix A) was issued by the Ethics Office of the College of Education at the University of South Africa. This prevented the researcher from taking advantage of the participants. The principals of the participating schools signed permission letters before data were collected (Appendix D). Teachers signed consent letters (Appendix C) and parents signed assent forms to give consent for learners to participate (Appendix E). Learners, whose parents gave consent, also signed assent forms before participating in the study (Appendix F).

The data were collected using interviews (individual and focus group) and observation of Physical Science classes using the smartboard. All Interviews were recorded using an audio recorder. An observation protocol (Appendix L) was used to observe teachers and learners during a lesson. Data were recorded in a table and sent to the data analyst who used ATLAS. ti software for analysis.

4.2 Results

The results of the study are presented in three parts which respond to the three research questions:

Part I: Findings concerning the teachers' experiences of using the smartboard for teaching and learning.

Part II: Findings concerning the learners' experiences of learning through the smartboard.

Part III: Discussions in terms of the teachers' and learners' experiences of using the smartboard for teaching and learning.

The next section presents the results of the teachers' experiences of using the smartboard for teaching and learning with specific reference to Grade 12 Physical Science.

4.3 Part I: Findings concerning the teachers' experiences of using the smartboard for teaching and learning

4.3.1 Introduction

The following sections present and discuss in detail the findings relating to the teachers' experiences of using the smartboard for teaching Grade 12 Physical Science. They include categories and relevant sub-categories drawn from the interviews and observation data (see Figure 4.1). Each category and sub-categories (how teachers use the smartboard for teaching, including the benefits of using the smartboard, the challenges of using the smartboard, the teachers' attributes in delivering a lesson, and the teachers' ICT skills and support in using the smartboard) are followed by a short description and extracts that serve as evidence from the interview data and observations. An overview of the findings, including commonalities arising from the two data gathering methods (interviews and observations), is presented in this section. The following section is an overview of the categories and sub-categories, as well as data collection methods relevant to the teachers' experiences.

4.3.2 The categories, sub-categories and data gathering methods related to the teachers' experiences of using the smartboard

The figure below presents an overview of the data gathering methods (see section 3.4.2) and the categories and sub-categories in terms of the teachers' perceptions of using the smartboard to teach Grade 12 Physical Science.

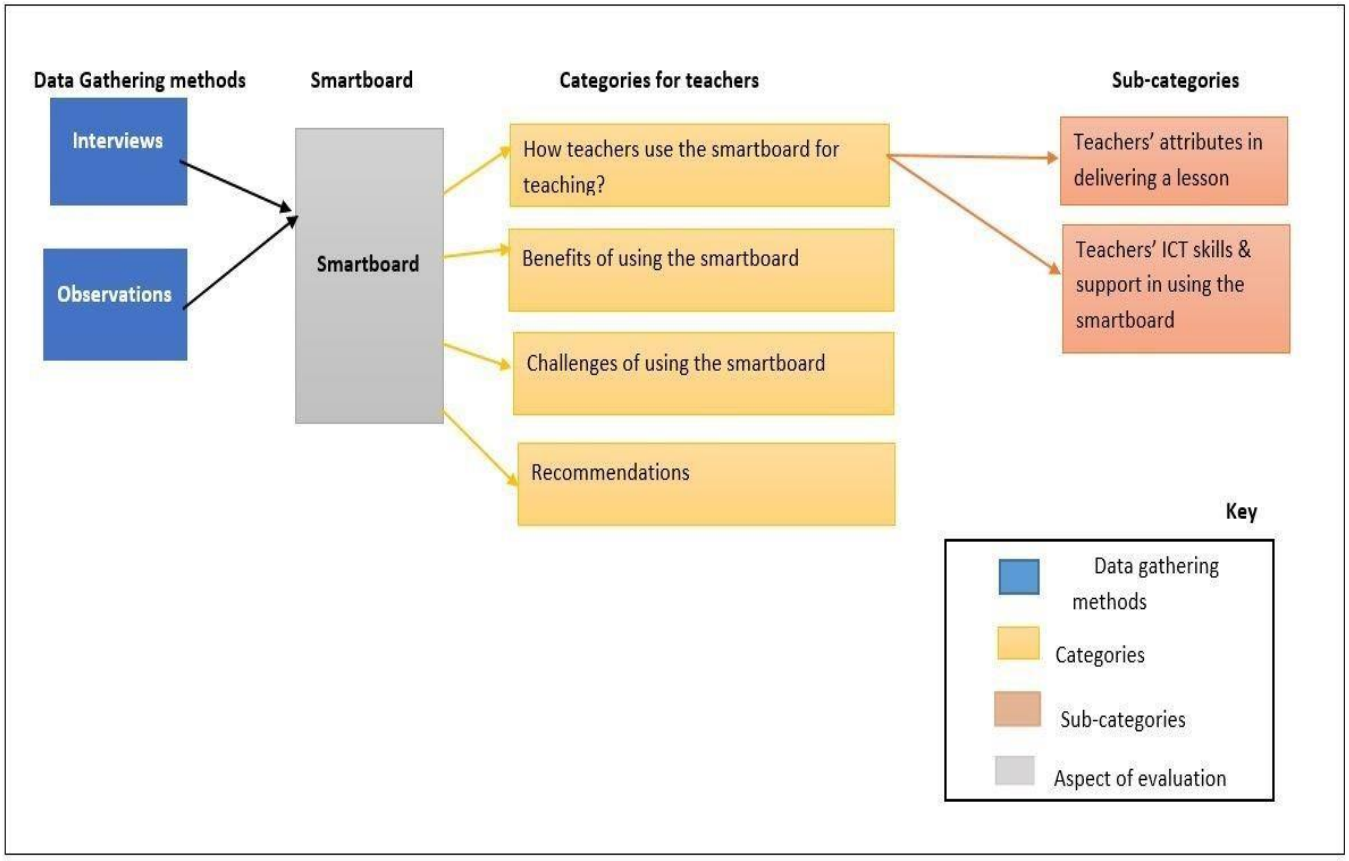

Figure 4.1: Data gathering methods, the categories and sub-categories of teachers' experiences of teaching using the smartboard

The figure above presents the data gathering methods, the categories and subcategories of the teacher's experiences of teaching through the smartboard. The results from the teachers' interviews and one lesson observation per participating school were presented simultaneously for a clearer understanding.

4.3.2.1 How teachers use the smartboard for teaching

a) Teachers' attributes to teaching a lesson

The results from the interviews revealed that the teachers had a good experience in teaching the subject (pedagogical content knowledge) in Grade 12 which is a strong attribute. See teachers' experience in Table 3.1. The teachers preferred to use the smartboard because of its multiple technologic advantages. All participant teachers indicated that teaching is easier when using the smartboard than when using the chalk board. The smartboard allowed them to use different teaching techniques to enhance learning. The teachers indicated that they prepare a lesson and save it on a USB (Universal Serial Bus or commonly known as a memory stick) and load it on the smartboard. This was observed by the researcher. Others use the textbooks installed on the smartboard with activities and the USB as just an addition. YouTube videos of the specific topic were downloaded using Wi-Fi and presented to learners.

Teacher B said:

> *They are drawn correctly [using smartboard]. Like momentum, the child does not know it is a car or a human being. We are able to google something that you are able to put there. I can save it on a memory stick. Then fit it on the smartboard. Like the Maxwell curves, I didn't get time to do them. Those curves …*

In addition, Teacher B pointed out, "…*some scientific concepts/structures are difficult to draw, but with the smartboard, they can be drawn more easily*…."

The researcher recorded in the observation protocol that the smartboard has pre-drawn structures either in the lesson plan or in the installed workbook. The teacher could just point at them rather than draw them incorrectly. The researcher observed that the teachers prepared lessons but they were not interactive. There was one-way communication. The teachers were talking while the learners were just listening most of the time, and only responded to questions asked by the teacher. The teachers typed in notes, presented them on the smartboard and the learners copied them. This activity took a lot of time as some learners were slow.

Observation notes revealed that the teachers know how to use the smartboard and enjoy using it as one teacher stated "…*it [the smartboard] makes life easier…"*

This is possible through the ability of the smartboard to save information for later use, unlike the erasable chalkboard. Difficult or abstract concepts can be explained better through the use of video and coloured pens and other features on the smartboard.

b) Teacher ICT skills and support in using the smartboard

All the teachers had been trained by the Department of Education and Training on the use of the smartboard. However, it cannot be taken for granted that they have skills to use the smartboard pedagogically. They have onsite support from technicians employed by the District Office of the Department of Education.

The teachers indicated during interviews that the smartboard has textbooks installed that can be used together with the learners during the lesson. However, Teacher C agreed that although textbooks exist in a digital version, the Physical Science prescribed textbook was only available in the printed version. Teachers A and B create their lessons plans. Teacher B alleged that the Physical Science facilitators from the District Office did not want them to use the installed textbooks and workbooks and prescribed that they should prepare their lessons.

Teacher B said that "*the current facilitators want us to prepare our own lessons which takes more time on preparation".*

Teachers do not use the smartboard for experiments and prefer to do these in the science laboratories. Teacher A believes that there may be experiments that can be done via the smartboard.

Teacher A said that "*Of late, I have not done any myself, but it is possible. You can look for a video whereby an experiment is being done. They can use it to observe when they are doing the practical part".*

The researcher noted that teachers and learners spoke about the usefulness of watching YouTube videos during lessons, but during lesson observation, they did not use YouTube videos because the focus was on teaching and learning using the smartboard.

Some of the benefits of the smartboard, as noted from the interviews and observations, are supported by Turel and Johnson (2012:381), Ersoy and Bozkurt

(2015:470) and Basmatzi (2014:326). A benefit from this study, which is in agreement with these authors, is that smartboards facilitate remembering and learning using visual media.

4.3.2.2 Benefits of using the smartboard

Visual learning is beneficial as learners can see what they are being taught, especially abstract concepts, such as volcanic eruptions. According to Mwalongo (2011:36), one of the benefits of ICT integration in classrooms is the easier demonstration of abstract concepts. Furthermore, learners can interact with the smartboard when doing classroom activities through visual learning, for example, by using the rewinding, forwarding and slow-motion functions. The following comments were recorded during interviews with teachers:

Teacher B said:

> *I think like other pictures, they [smartboards] help them because we cannot draw them [pictures]… I realised that when they see something, it stays in the mind unlike when they don't see something. When they see the picture, it stays a long time in the mind of the child. Picture helps them.*

Teacher C said that "*learners are able to understand the Physical Science content when they watch videos, video clips …".*

From the researcher's observations, the teachers had smartboard skills. Due to a power failure, smartboard skills could not be fully observed at School C. The teacher had to move the class from the smartboard room to another class that had a chalk board. Teachers in Schools A, B and D knew how to use the smartboard and its accessories, such as the different coloured pens. They knew how to move from slide to slide or from page to page as they went through the lesson.

Another benefit is saving lessons on the smartboard. Prepared lessons and activities can be saved on the USB for use in other classes. These included notes that teachers need students to write down. Activities and corrections can be saved on the USB or the smartboard rather than being erased and then re-written every time a new class uses the venue. Saved lessons can be used again during the following year.

The smartboard has other computer icons that the teachers can use for additional information. Teacher D commented, "*and there are some icons (such as Google Chrome and colouring tools) you can use to enhance your teaching".* Teacher B added that "*more information can be searched via the Internet connected to the smartboard".*

Access to the internet assists in searching for more information without going to an internet café or searching magazines. The ability to search for more information encourages lifelong learning while saving time.

4.3.2.3 Challenges of using the smartboard

During the data collection period, two of the originally identified schools could not participate, because the smartboards at one school had been stolen at the beginning of 2018, and the other school was still waiting for the smartboards to be installed. School B's smartboard had been stolen, but the Grade 11 smartboard was made available after school so that the Grade 12 teacher and learners could use it.

All participant teachers raised the concern during interviews that some learners became disengaged and focused on the video rather than the content. Others were slow in completing activities or writing notes projected on the smartboard, according to Teachers A and B. When left alone to revise, the learners misused the smartboard by playing music or movies from YouTube videos.

All participant teachers had encountered power failures during the use of the smartboard. Other technological challenges like screen freezing were reported by the teachers. Power failures also came up as one of the challenges at School A and D who had a whiteboard mounted to substitute for the smartboard during power failures.

Teacher B said:

> *I wish they can try to improve on the issue of the virus. Because the smartboard freezes. You end up not wanting to use it. That is why when I go to class, you see, I carry my lesson plan, and I print it [the lesson plan] because it [the smartboard] can jam.*

Viruses that cause freezing on the smartboard can be resolved with antivirus software. Antivirus software is used on ICT devices to detect, remove or prevent viruses that may damage or remove information.

The technicians offer technological support but they do not provide pedagogical support for the teachers. The teachers need to know more about how to integrate the smartboard more effectively into teaching and learning.

When the MEC, Panyaza Lesufi, introduced the smartboards in 2016, learners were also given tablets to use in conjunction with the smartboards (Sekhonyane, 2014:1). Three of the schools (A, B and C) did not have the tablets during the data collection period. The learners can use tablets like a workbook. They respond to activities on the tablets as they work together with the teachers. This saves a lot of time for the lesson. Tablets work like a smartboard.

Teacher B said:

> *So, it works well if they have the tablets. If they don't have the tablets… Let's say I am giving them information, it's like I am giving them information from the chalkboard now because they need to write… Now it is [the smartboard] no longer saves our time that we were talking about.*

Some schools did not have tablets anymore because past learners had not returned them at the end of the academic year. Others had been stolen. Some schools do not use them because they distract the learners.

Teacher A said:

> *The tablets, they have stopped them because they disturb learners. Learners, they don't use them efficiently for school; they use them for other things, always there on their thing called what? Their thing, the Wi-Fi. When you tell them to come to class, they tell you they are doing assignments. Some of them are no more working.*

The smartboard and tablets cannot be used to their full capacity due to the issues of power failure and theft (Mzekandaba , 2017). Crime is a national challenge.

4.3.3 Summary of results in terms of the teachers' experience

Teachers mentioned during their interview that they have basic smartboard skills (Appendix M). They prefer the smartboard over the chalkboard as it makes teaching easier. Difficult concepts, such as momentum, can be easily explained using YouTube videos or pictures saved on the USB. Work saved on the smartboard can be used at a later stage without being deleted, unlike the chalkboard where work is continuously erased. Except for the challenges of theft and power failures, the teachers had positive experiences with teaching using the smartboard.

4.4 Part II: Findings concerning the learners' experiences of learning Physical Science through the smartboard

4.4.1 Introduction

The following section presents and discusses in detail the findings relating to the Grade 12 learners' experiences of learning using the smartboard. It presents the learners' voice and the researcher's observation. The data are presented in categories and sub-categories which are: how learners use the smartboard for learning, including the benefits of using the smartboard; the challenges of using the smartboard; the teachers' attributes in delivering a lesson; and the teachers' ICT skills and support in using the smartboard including the challenges and recommendations. Each category and its sub-categories are followed by a short description and extracts that serve as evidence from the interview data and observations.

4.4.2 The categories, sub-categories and data gathering methods related to the learners' experiences of using the smartboard

Figure 4.2 presents an overview of the data gathering methods (refer to section 3.4.2) and the categories and sub-categories in terms of the Grade 12 Physical Science learners' experiences of learning through the smartboard.

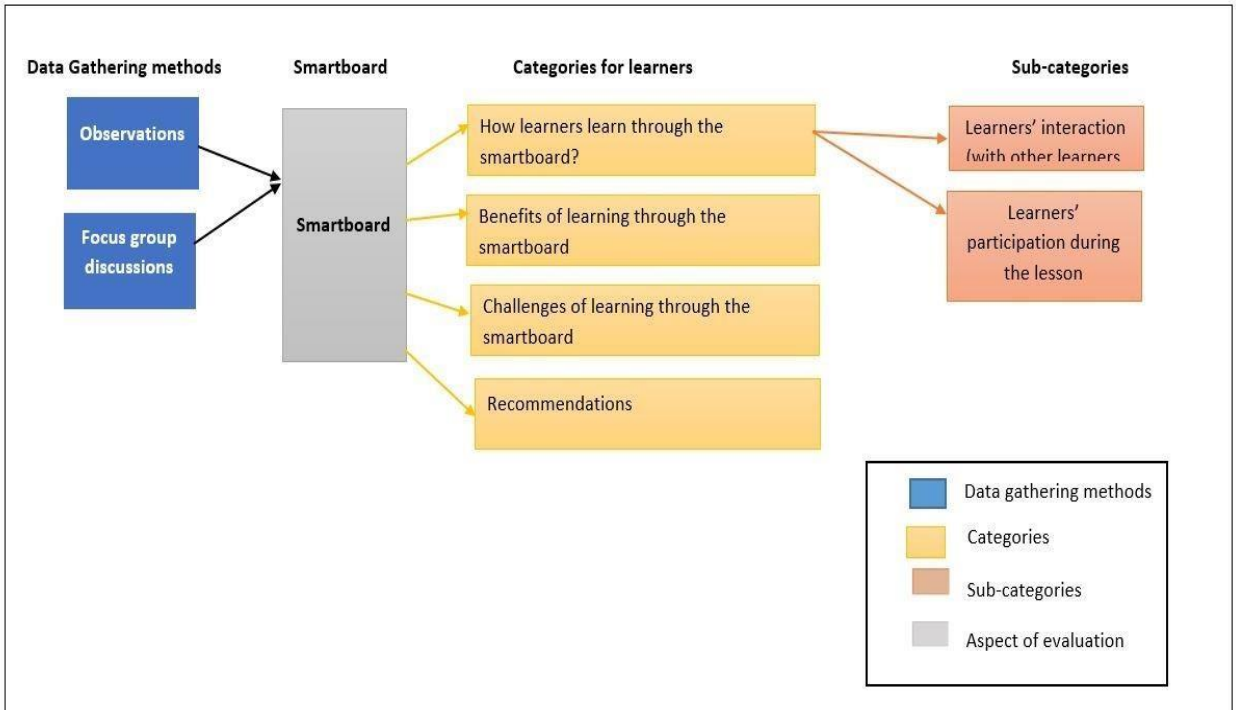

Figure 4.2: Data gathering methods, the categories and sub-categories of learners' experiences of learning through the smartboard

Results from the focus group interviews and the observation protocol for Grade 12 learners, who used the smartboard for learning, are presented in Figure 4.2 above. The figure represents categories and sub-categories derived from the analysis of the data. Results from the observation protocol have been consolidated and included simultaneously for a better understanding of the findings.

4.4.2.1 How learners learn through the smartboard

a) Learners' interaction and participation

The availability of the previous year's examination questions on the smartboard assisted learners. It helped them to prepare thoroughly for their forthcoming examination and to develop their confidence.

Learner in School D said, "*Like last year when we were using the chalk board, we could not be exposed to question papers. You find that you get to the exams and you are not used to the question paper. You become nervous".*

The researcher observed that Teacher D was revising with the learners using the previous year's examination questions that were on the smartboard. The learners

interacted with the questions on the smartboard. They used the smartboard pens and could move from one slide to the next. They also referred to their workbooks during the question-answer sessions.

Since the tablets and the smartboard have textbooks installed, learners do not have to carry heavy textbooks to school. Additionally, learners have the opportunity to work on previous years' examination papers together with other learners and the teacher using the smartboard. These practical exercises help them to become familiar with examination questions that occur during the real examination process.

The use of visual aids benefits the learners. The different colours used when writing on the smartboard helps them to remember the content taught. This was derived from some of the learners' remarks. A learner in School C said, "*They use the different colours when they write … The brain can remember the colours.* He continued, "*I think it's advantageous because the others can learn using visualising and others can use pictures to see what's happening".*

A learner in School A agreed and said, "*We can see the things that they teach; we are not just imagining them".*

The researcher observed that learners in the schools are comfortable with being taught using the smartboard. They interacted with the lesson even though they did not physically touch the smartboard except at School D. In the other schools, they were only allowed to switch it on and off.

4.4.2.2 Benefits of learning through the smartboard

The learners agreed that the smartboard is beneficial in that it has all the resources necessary to learn Physical Science constructively.

School D Learner said:

> *Like the smartboard, they have question papers. There are more videos and we communicate with teachers using the tablets. And the textbooks. We find recordings inside the tablets. When we do experiments in class you can take a record using the tablets.*

The researcher observed that the workbooks on the smartboard have many activities per topic. The teachers could work between the slides of the textbook and the questions on the examination papers. This teaches the learners how to do referrals.

4.4.2.3 Challenges of learning through the smartboard

According to the learners interviewed, some learners are slow and others are challenged by the brightness of the smartboard. The following are some of the learners' remarks.

A learner in School B said, "*This affects learners in a negative way because when he connects to the laptop, they move fast. Because some learners are slow, it's like they are watching a bioscope.*

A learner in School C said, "*We can't see clearly. My eye-sight. We cannot all just come to the front. Some of us cannot see clearly".*

A learner in School B said, "*No, they [smartboards] steal them and others did not return them",* while a learner in School D confirmed that "*people steal our tablets".*

Miller Vision Specialities (2015) supports the issue of eye-sight challenges. They state that, although regular use of digital devices will not damage vision, extended use of technology at school or for homework can lead to a temporary vision condition called computer vision syndrome (CVS). Symptoms of CVS include eyestrain, fatigue, burning or tired eyes, the inability to focus, headaches, blurred vision, double vision or head and neck pain. In this research, the teachers considered CVS and informed learners to take care during their work on digital devices.

The challenges presented by power failures and viruses that cause the smartboard to freeze need more attention.

A learner in School A said, "*No electricity, no learning … No generator to back it up".* A learner in School B said, "*It freezes … Not regularly".* A learner in School A said, "*We do use the smartboard alone but we ask for the teacher's permission. The person who went to the teacher will be responsible".* A learner in School C said, "*We can use it only after school but under supervision".*

Learners are not allowed to work on the smartboard without the supervision or permission of the teacher. Should permission be granted, the requestor is liable for the safety of the smartboard.

The learners' interaction with the smartboard was observed only in School D. Learners were allowed to work on different activities on the smartboard, whereas at the other schools, they were only asked to switch it on and off. From the focus group interviews, the learners indicated that they know how to use the smartboard. When given permission, they have revised using the smartboard after school. Students did activities in their workbooks and only responded to the teacher while doing corrections.

The teachers' and learners' experiences are discussed in the next section.

4.4.2.4 Summary of results in terms of the learners' experience

Learners preferred the smartboard to the chalkboard. They did most of the activities in their workbooks and not on the smartboard. Not having to carry heavy textbooks to schools pleases the learners as it is a relief not to have to carry a heavy load or worry about the loss of schoolbooks.

The next section presents discussions in terms of teachers' and learners' experiences of using the smartboard.

4.5 Part III: Discussions of the teachers' and learners' experiences of using the smartboard for teaching and learning Grade 12 Physical Science

4.5.1 Introduction

The following section covers discussions in terms of the teachers' and learners' experiences of using the smartboard for teaching and learning Grade 12 Physical Science. The discussions are based on the results from interviews and lesson observations at the four participating schools.

4.5.2 Reflections during observations and interviews

In the study, the researcher felt confident that the smartboard was shown to be a good ICT instrument to influence learning and teaching. During the practical research, the

teachers demonstrated that they were comfortable when using the smartboard for teaching. The teachers were ICT competent and they were able to use some of the accessories on the smartboard. However, there was minimal interaction between the learners and the smartboard as reported in the observation protocol (Appendix L).

4.6 Discussions

The learners as a whole were hesitant to stand up and switch on the smartboard except for one or two learners. This may have been due to the restrictions that the schools have in place to protect the smartboards, as well as the teachers' warnings about the misuse of smartboards. This is supported by Trucano (2019:3). It may also be due to the teachers being afraid that learners might break the smartboards as they are not trained in how to use them (Al-Faki & Khamis, 2014:154). Crime continues to be a hindrance in the maximum use of ICT devices for learning. School C received their smartboards with tablets in February 2018. Due to crime, the learners were keeping them at home. Learners at the school did not feel safe carrying them to school.

Teachers and learners preferred the smartboard over the chalkboard and the fact that, because they had smartboards, they did not have to carry heavy books every day. Lessons were saved for further use to improve visual learning which assists with the learning of abstract concepts. However, learners did not participate much with the smartboard but only responded to the teacher's questions.

Thus, there was minimal interaction between the smartboard and the learners. Even though it was mentioned during the focus group interviews, learners did not demonstrate any competencies in the use of the smartboard. This may be due to limitations from the school concerning the security of the smartboards. Learners were not allowed to use the smartboard without the supervision of the teachers as there was suspicion that they would play movies on the smartboard instead of using it for learning. Even if they wanted to do peer learning after school, they did not have access to the smartboard. Learners indicated in the focus group interviews, that they learnt well from the visual learning when using the smartboard. This was not observed during the lesson. Teachers only used word documents and the pen and erasers from the smartboard with no diagrams, charts, mind maps, etc.

The three data collection methods used yielded a variety of results with some commonalities. This ensured credibility as supported by the triangulation method (interviews, focus group and observation). Johnson and Christensen (2012:439) explain triangulation as the term used when the researcher seeks to converge and corroborate results using different methods for the same phenomena.

Visual learning and some stored diagrams make it easier for the teachers to explain abstract concepts and for learners to visualise them. A video showing a volcano erupt can offer a learner a greater insight into this type of seismic event if he or she has never seen a volcanic eruption. When teaching about the layers of the earth, a video or diagram will give the learners a better understanding of how the earth is made up. Mwalongo (2011:45) mentions the impact of ICT on students' learning by stating that the proper use of these resources makes it easier for the student to understand the subject matter using different perspectives. The use of visual learning with explanations makes it easier for the learners to understand what they are watching without the interruption of the teacher's voice. This is supported by the TPACK framework which emphasizes the relationship between technology, pedagogy and content knowledge. Showing a video without the correct pedagogical explanation does not benefit the learners.

A great deal of participation can result from the learners being stimulated by the smartboard. The main purpose for the use of the smartboard is to stimulate learners to learn and engage in the content being taught (Molotsi, 2016:104).

The researcher observed that power failures and the lack of generators as a back-up power source (Lorbel Tech, 2018) were affecting the use of the smartboard in all the participating schools. This situation occurred during data collection at School C. The teacher had to move from one class to the next one which had a chalk board. This was time-consuming and affected the learners' concentration. Crime is also a major challenge. The majority of schools had lost their smartboards due to crime and the learners and teachers had to use chalk boards even though they were prepared for teaching and learning using the smartboard (Ramorola 2010:133).

According to an essay written by a student through UKEssays (2015), there are positive and negative impacts of the use of ICT for teaching and learning. The writer cites the following positives:

- It helps students with activities that are available on websites.
- It is part of the social system, integrating meaningful communication within the educational sector.
- It assists with research during assignments.

Learners are not able to do research during class activities, as this requires additional time. The only chance they have to do this is when they use the tablets after school. To curb the misuse of tablets, Fu (2013:115) recommends that there should be orientation and training for students. Learners should acquire specific technical skills to facilitate learning in an ICT environment. Continuous smartboard training should not be only for the teachers but also for the learners (Mota, Oliveira & Henriques, 2016:83). Although they may know technology more than teachers (Al-Faki & Khemis, 2014:137), they still need the technical skill to safely operate the smartboard.

4.7 Conclusion

This chapter has presented findings in relation to the influence of the smartboard on the teaching and learning of Grade 12 Physical Science. The data were presented in three parts. The first part, section 4.3, presented findings on the perceptions of the teachers when teaching using the smartboard. Section 4.4 discussed findings on the learners' experience in learning through the smartboard. The third section offered discussions and reflections in terms of the teachers' and learners' experiences. The next chapter examines the conclusions, recommendations and limitations of the study.

CHAPTER 5 CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

5.1 Introduction

The previous chapter discussed data analysis and the results. Data collected from teachers through face-to-face individual interviews and one lesson per school observation were analysed and categorised. In order to establish whether the objectives of the study have been met, the purpose of this chapter is to provide an overview of the research with a summary of each chapter. Suggestions for further study, recommendations, limitations and the researcher's reflections are also presented in this chapter. This chapter summarises how the results relate to the research question and sub-questions, and how teachers can advance from the deductions drawn when using the smartboard in the teaching of Grade 12 Physical Science in the South African context.

5.2 Conclusions

5.2.1 An overview of the orientation, the problem statement and the aim of the study (Chapter 1)

Physical Science Grade 12 results have been below average in schools, even though schools have been provided with smartboards. The previous chapters informed about the setting up of smartboards in Gauteng schools. The problem identified in this study (see section 1.3) was that no appropriate instructional methods had been investigated in the current literature about teaching Physical Science in Grade 12 using the smartboard.

The overall aim of this study was to explore how the use of the smartboard influences the teaching and learning of Grade 12 Physical Science in the Tshwane District, Gauteng Province, South Africa. With this aim in mind, the research question and sub-questions were derived (see section 1.5). Chapter 1 outlined a gap in the literature regarding the effect of using ICT in teaching and learning Physical Science. An appropriate research methodology was discussed, which provided a basis for practical research in the Physical Science Grade 12 classrooms.

5.2.2 Literature review (Chapter 2)

This chapter focused on the literature review leading to the theoretical frameworks for the teaching and learning of Physical Science using ICT, in particular the smartboard. The literature informed on the importance and use of the smartboard globally and locally and included the benefits and challenges (see section 2.2.6). The study used the Technology, Pedagogy and Content Knowledge (TPACK) framework as this covers the complex relationship between technology, pedagogy, and content that enables teachers to develop appropriate and context-specific teaching and learning strategies (Koehler et al., 2013:103).

5.2.3 Research design (Chapter 3)

This chapter covers the research methodology used in the study including the interpretive paradigm as the philosophy underlying the study. From the literature and the explorative nature of this study, it was determined that a qualitative research approach was the most appropriate for this study (see section 3.4.1). The learners' and teachers' perceptions and perspectives regarding the use of the smartboard were investigated as little has been researched on the teaching and learning of Physical Science through ICT, especially using the smartboard. A multiple case study was appropriate since more than one school was studied to gain an in-depth understanding of the use and effectiveness of smartboards. The data collection methods used in the study were semi-structured interviews, focus group interviews and the observation of lessons. All the participants signed consent forms before participating in the study. Validity and reliability issues with ethical considerations were taken into account.

The methods of data analysis were discussed, as well as validation through triangulation. De Vos et al. (2005:361) describe data triangulation as the use of more than one data source in a study. McMillan and Schumacher (2010:367) explain that inductive analysis is a systematic process of coding, categorising and interpreting data to provide an explanation for a single phenomenon. Inductive analysis was applied to the teachers' and learners' experiences of teaching and learning Physical Science using the smartboard.

5.2.4 Findings of the research (Chapter 4)

The smartboard provided an opportunity for learners to engage in meaningful learning and provided teachers with additional ICT means to facilitate the learning and teaching of Physical Science in Grade 12 (Gon, 2015:1).

The teachers and learners were the two sources of data that communicated their experiences of using the smartboard. Categories and sub-categories were derived from the analysis of the data gathered through interviews and observations, which were interrelated and discussed in terms of the literature, and in relation to the major objectives in this study. Findings from observations and interviews were triangulated and discussed.

The results from the teachers' and learners' experiences were analysed thematically leading to three categories, namely the use of the smartboard, the benefits and the challenges of teaching using the smartboard. According to Molotsi (2014:14), Fu (2013:113) and Mdlongwa (2012:5), one of the benefits of ICT is active learner participation. However, this was not observed during the lesson presentation.

The most significant benefit of using the smartboard is the interactivity it allows during teaching and learning in the Physical Science classroom. However, in this study, this interactivity was limited due to challenges ranging from power failures to theft to improper use of the smartboard. Another challenge was the lack of pedagogy in teaching using the smartboard

Although the teachers had ICT skills and were able to operate the smartboard, they lacked the pedagogy. The teachers preferred to stand at the front of the classroom to explain the lesson. This was also reported by Al-Faki and Khamis (2014:136), who found that even though teachers had smartboards skills, there was still the "chalk-and-talk" issue in the classrooms and the desire for pen-paper based assessments. This indicated that teachers require additional training so that they can link ICT to pedagogy as emphasised by the TPACK framework (Koti, 2016:108).

It was not clear how much interactivity occurred when it came to the learners, as they were only allowed to switch the smartboard on or off, except at School D. Moreover, at the same school, only two learners worked on the smartboard. The findings emphasised the lack of appropriate pedagogy. For example, instead of writing notes

on the board about acids and bases, the teacher could have given an assessment activity that learners could have completed after watching a video on acids and bases.

Included in the diverse problems regarding the use of smartboards, theft and the apparent lack of the learners' knowledge on the use of ICT also need to be addressed.

All of the issues described above assisted in providing an answer to the research question: "How does the use of the smartboards influence the teaching and learning of Grade 12 Physical Science in Tshwane District, Gauteng Province, South Africa?"

5.2.5 Justification of this study in terms of its contribution to the body of knowledge in ICT

According to the results of this study, it can be tentatively concluded that this study has made a contribution to the body of knowledge regarding ICT, in particular, for the teaching and learning of Grade 12 Physical Science using the smartboard. Teachers and learners provided insight into the contribution and benefits made to their teaching and learning from visual learning, ICT integration in classrooms and having the ability to provide easier demonstrations of abstract concepts. For example, teachers were able to demonstrate the abstract concept of momentum using visual aids. In addition, the use of mind maps rather than notes that take time proved beneficial to the learners. Saving lessons for later use was also highlighted. The challenges mentioned, such as theft, power failures and the lack of learners' interaction, if attended to, can improve the influence of the smartboard for teaching and learning.

5.3 Recommendations

Based on the findings of this study, the following recommendations were derived:

- Smartboard training should not be a once-off process. It should be an ongoing process to ensure continuous support for teachers. Teachers should also attend ICT training workshops or in-service training about how to plan and present technology integrated lessons in Physical Science classrooms as emphasized by TPACK.

- Collaboration through conferences, joint research or online meetings with other experienced teachers may assist in addressing common challenges

faced during lesson presentations. This will enable teachers to showcase their best practices during lesson delivery and in this way share positive experiences and learn from each other.

- Challenges, such as knowing how to use the smartboard effectively, and how to ensure and encourage learners to remain engaged during the lessons should be addressed to enhance effective teaching and learning.

- The Department of Education should ensure that every school has a smartboard, as well as an electrical generator and a whiteboard as support mechanisms during power failures.

- ICT theft is an ongoing challenge in schools. The Department of Higher Education and Training (DHET) and schools should form partnerships with the community and educate them to ensure that everyone is responsible for the security of their children's school equipment. Community-based workshops can be of importance in this regard.

- There should be measures in place to protect the smartboards when the teacher is absent from the classroom, rather than just having the learners locked out.

- Learners need to be trained on how to use the smartboard, and they should be given more opportunities to use and navigate the smartboard on their own.

The researcher acknowledges that the improvement of these factors would enhance the effective realisation of the aims of this study.

5.4 Limitations of the research

There were certain limitations that need to be discussed in terms of the results of this study:

- Approval from the District Office of the Department of Education to access schools was received during the March assessment period. This delayed data collection. When schools reopened, two of the schools had had their

smartboards stolen. The researcher had to request permission to collect data from other schools not originally identified.

- A power failure occurred at School C during data collection. The teacher was forced to move the learners from the classroom with the smartboard to another one with a chalk-board. The lack of generators at schools affected data collection just as it affected lesson presentations through the smartboard. This affected data collection since there was no lesson observed.

- The smartboards that had been placed in the schools in Gauteng Province were originally used with tablets (Sekhonyane, 2015:1). However, the researcher was not able to observe how the tablets were used by learners in conjunction with the smartboard because the majority of learners did not have a tablet as many had not been returned by the previous year's students or had been lost.

5.5 Closing remarks

This study on the influence of the smartboard on the teaching and learning of Grade 12 Physical Science has been completed. The study can assist teachers in promoting teaching and learning using the smartboard as an ICT component. An overview of some theoretical frameworks as a basis for this research and its findings has been presented.

This study was an attempt to research and improve the practice of ICT use in South African schools and the teaching and learning of Grade12 Physical Science, which poses a challenge for educators in terms of the appropriate pedagogy applicable for facilitating learning with smartboards. This is supported by the TPACK framework. Recommendations and limitations of the research were discussed. From the results, it can be tentatively concluded that the use of the smartboard does have a positive influence on the teaching and learning of Physical Science. However, the challenges presented are a hindrance and they need to be addressed if the effective use of the smartboard is to be realised. Since smartboards have now been installed in Grade 11 and Grade 10 classes, this opens up additional areas where the impact of the smartboard on academic achievement can be further studied.

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APPENDIX A: ETHICAL CLEARANCE CERTIFICATE

UNISA

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2018/02/14

Ref: 2018/02/14/07154321/27/MC
Name: Mrs RM Tefo
Student: 07154321

Dear Mrs Tefo

Decision: Ethics Approval from 2018/21/14 to 2021/02/14

Researcher(s): Name: Mrs RM Tefo
E-mail address: teform@gmail.com
Telephone: +27 12 441 5777

Supervisor(s): Name: Prof M Jakovljevic
E-mail address: jakovm@unisa.ac.za
Telephone: +27 76 249 0383

Title of research:

The influence of Smartboard on the Teaching and Learning of grade 12 Physical Science in Tshwane District, Gauteng Province, South Africa

Qualification: M Ed in Curriculum and Instructional studies

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2018/02/14 to 2021/02/14.

*The **Medium risk** application was reviewed by the Ethics Review Committee on 2018/02/14 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date **2021/02/14**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2018/02/14/07154321/27/MC** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Dr M Claassens
CHAIRPERSON: CEDU RERC
mcdtc@netactive.co.za

Prof V McKay
EXECUTIVE DEAN
Mckayvi@unisa.ac.za

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APPENDIX B: 2017 GDE RESEARCH REQUEST FORM

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

For admin. use only:
Ref. no.:
Enquiries: 011 355
Gumani Mukatuni

2017 GDE RESEARCH REQUEST FORM

REQUEST TO CONDUCT RESEARCH IN INSTITUTIONS AND/OR OFFICES OF THE GAUTENG DEPARTMENT OF EDUCATION

1. PARTICULARS OF THE RESEARCHER

1.1	**Details of the Researcher**
a) Surname and Initials:	Tefo RM
b) First Name/s:	Regina Mosima
c) Title (Prof/Dr/Mr/Mrs/Ms):	Mrs
d) Student Number:	7154321
e) SA ID Number:	6811189434080
f) Work permit no. (If not SA citizen)	-

1.2	**Private Contact Details**
a. Home Address	***c. Postal Address (if different)***
24 Madiba Street	P O Box 569
Atteridgeville	Atteridgeville
b. Postal Code: 0008	***d. Postal Code:*** 0008

e. Tel:-	***f. Cell: 0827498395***
g. Fax: -	***h. E-mail:teform@unisa.ac.za***

2. PURPOSE & DETAILS OF THE PROPOSED RESEARCH

2.1	**Purpose of the Research (Place a cross where appropriate)**	
Undergraduate Study - Self		
Postgraduate Study - Self		x
Private Company/Agency – Commissioned by Provincial Government or Department		
Private Research by Independent Researcher		
Non-Governmental Organisation		
National Department of Education		
Commissions and Committees		
Independent Research Agencies		
Statutory Research Agencies		
Higher Education Institutions only		
2.2	**Full title of Thesis / Dissertation / Research Project**	
The influence of the Smartboard on the Teaching and Learning of Grade 12 Physical Science.		
2.3	**Value of the Research to Education (Attach Research Proposal)**	
Research proposal attached		
2.4		**Date**
a. <u>Estimated</u> date of **completion of research in GDE Institutions**		**June 2018**
b. <u>Estimated</u> date of **submission of Research Report /Thesis/Dissertation and Research Summary to GDE:**		**November 2018**
2.5	**Student and Postgraduate Enrolment Particulars**	

a. Name of institution where enrolled:	Unisa
b. Degree / Qualification:	Master's in Education : Curriculum Studies
c. Faculty and Discipline / Area of Study:	Education
d. Name of Supervisor / Promoter:	Prof Maria Jakovljevic

2.6	**Employer (or state Unemployed / or a Full Time Student) :**
a. Name of Organisation:	Unisa
b. Position in Organisation:	Regional Academic Coordinator
c. Head of Organisation:	Ms Moipone Masalesa
d. Street Address:	Cnr Justice Mahommed & Steve Biko street
	Sunnyside
e. Postal Code:	0003
f. Telephone Number (Code + Ext):	0124415720
g. Fax Number:	-
h. E-mail address:	masalmc@unisa.ac.za

2.7	**PERSAL Number (GDE employees only)**

3. PROPOSED RESEARCH METHOD/S

(Please indicate by placing a cross in the appropriate block whether the following modes would be adopted)

3.1 ***Questionnaire/s (If Yes, supply copies of each to be used)***

YES		**NO**	**x**

3.2 ***Interview/s (If Yes, provide copies of each schedule)***

YES	**x**	**NO**	

3.3 ***Use of official documents***

YES		**NO**	**x**
If Yes, please specify the document/s:			

3.4 ***Workshop/s / Group Discussions (If Yes, Supply details)***

YES	**x**	**NO**	
Focus group interview of 8-10 Grade12 learners			

3.5 ***Standardised Tests (e.g. Psychometric Tests)***

YES		**NO**	**x**
If Yes, please specify the test/s to be used and provide a copy/ies			

4. INSTITUTIONS TO BE INVOLVED IN THE RESEARCH

4.1 ***<u>TYPE</u> and <u>NUMBER</u> of Institutions (Please indicate by placing a cross alongside all types of institutions to be researched)***

INSTITUTIONS	Write NUMBER here
Primary Schools	
Secondary Schools	X 4
ABET Centres	
ECD Sites	
LSEN Schools	
Further Education & Training Institutions	
Districts and / or Head Office	

4.2 **Name/s of institutions to be approached for research (Please complete on a separate sheet if space is found to be insufficient).**

Name/s of Institution/s
Flavious Mareka High School
Dr Nkomo High School
Bokhoni Technical High School
David Helen Peta High School

4.3 District/s where the study is to be conducted. ***(Please indicate by placing a cross alongside the relevant district/s)***

District/s			
Ekurhuleni North		***Ekurhuleni South***	
Gauteng East		***Gauteng North***	**x**
Gauteng West		***Johannesburg Central***	
Johannesburg East		***Johannesburg North***	
Johannesburg South		***Johannesburg West***	
Sedibeng East		***Sedibeng West***	
Tshwane North		***Tshwane South***	
Tshwane West			

If Head Office/s (Please indicate Directorate/s)

4.4 <u>Approximate</u> number of learners to be involved per school (Please indicate the number by gender)

Grade	*1*		*2*		*3*		*4*		*5*		*6*	
Gender	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**
Number												

Grade	*7*	*8*	*9*	*10*	*11*	*12*

Gender	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**	**B**	**G**
Number											**10**	**10**

4.5 <u>Approximate</u> number of educators/officials involved in the study (Please indicate the number in the relevant column)

Type of staff	***Educators***	***HODs***	***Deputy Principals***	***Principal***	***Lecturers***	***Office Based Officials***
Number	**4**					

Groups	***x***	***Individually***	**x**

4.6 Letters of Consent (Attach copies of Consent letters to be used for Principal, SGB and all participants. For learners also include parental consent letter) Attached

4.7 Are the participants to be involved in groups or individually?

4.8 Average period of time each participant will be involved in the test or other research activities (Please indicate time in minutes for ALL participants)

Participant/s	**Activity**	**Time**
Teachers	**Semi- structured interviews**	**45 hour**
Learners	**Focus group**	**45 min**
Class	**Observation**	**45-60min**

4.9 Time of day that you propose to conduct your research.

***Before* school hours**		***During school hours (for limited observation only)***	**x**	***After* School Hours**	***x***

SEE Condition 5.4 on Page 7

4.10 School term/s during which the research would be undertaken

First Term	***x***	***Second Term***		***Third Term***	

5. CONDITIONS FOR CONDUCTING RESEARCH IN GDE

Permission may be granted to proceed with the above study subject to the conditions listed below being met and permission may be withdrawn should any of these conditions be flouted:

5.1 ***The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.***

5.2 ***The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;***

5.3 ***Research may only commence from the second week of February and must be concluded by the end of the THIRD quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.***

5.4 ***Research may only be conducted BEFORE or AFTER school hours so that the normal school program is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.***

5.5 ***Items 3 and 4 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and paid for by the Gauteng Department of Education.***

5.6 ***It is the researcher's responsibility to obtain written consent from the SGB/s; principal/s, educator/s, parents and learners, as applicable, before commencing with research.***

5.7 ***The researcher is responsible for supplying and utilizing his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institution/s, staff and/or the office/s visited for supplying such resources.***

5.8 ***All research conducted in GDE Institutions is anonymous. The names and personal details of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may neither be asked nor appear in the research title, report / thesis/ dissertation or GDE Research Summary.***

5.9 ***On successful completion of the study the researcher must supply the Director: Education Research and Knowledge Management, with electronic copies of the Research Report, Thesis, Dissertation as well as a Research Summary (on the GDE Summary template). Failure to submit these documents may result in future permission being withheld, or a fine imposed for BOTH the Researcher and the Supervisor.***

5.10 Should the researcher have been involved with research at a school and/or a district/head office level, the Director/s and school/s concerned must also be supplied with a GDE Summary.

5.11 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;

6. DECLARATION BY THE RESEARCHER
6.1 I declare that all statements made by myself in this application are true and accurate.
6.2 I have read, understand and accept ALL the conditions associated with the granting of approval to conduct research in GDE Institutions and I undertake to abide by them. I understand that failure to comply may result in permission being withdrawn, further permission being withheld, a fine imposed and legal action may be taken against me. This agreement is binding.

6.3 I promise once I have successfully completed my studies, (before graduation) or on successful project completion, to submit electronic copies of my Research Report / Thesis / Dissertation as well a GDE Summary on the GDE template sent to me with my approval letter or found on www.education.@gpg.gov.za	
Signature:	
Date:	

7. DECLARATION BY SUPERVISOR / LECTURER / PROMOTER
7.1 I declare that: (Name of <u>Researcher</u>)……
7.2 is enrolled at the institution / employed by the organisation to which the undersigned is attached.
7.3 The questionnaires / structured interviews / tests meet the criteria of: • ***Educational Accountability;*** • ***Proper Research Design;*** • ***Sensitivity towards Participants;*** • ***Correct Content and Terminology;*** • ***Acceptable Grammar;*** • ***Absence of Non-essential / Superfluous items; Ethical clearance***
7.4 The student / researcher has agreed to ALL the conditions of conducting research in GDE Institutions and will abide by them.

7.5 I will ensure that after success completion of the research degree / project / study an electronic copy of the Research Report / Thesis / Dissertation and a Research Summary (on the GDE template) will be sent to the GDE. Failure to submit the Research Report, Thesis, Dissertation and Research Summary may result in: permission being withheld from BOTH the student and the Supervisor in future and a fine may be imposed.	
7.6 Surname:	
7.7 First Name/s:	
7.8 Title:	
7.9 Institution / Organisation:	
7.10 Faculty / Department:	
7.11 Telephone:	
7.12 E-mail address:	
7.13 Signature:	
7.14 Date:	

ANNEXURE A: GROUP RESEARCH

This information must be completed by every researcher/ student / field worker who will be visiting GDE Institutions for research purposes, besides the main researcher who applied and the Supervisor/ lecturer / Promoter of the research.

By signing this declaration, the researcher / students / fieldworker accepts the conditions associated with the granting of approval to conduct research in GDE Institutions and undertakes to abide by them.

Supervisor/ Promoter / Lecturer's Surname and Name……N/A……

DECLARATION BY RESEARCHERS / STUDENTS: N/A

Surname & Initials	Name	Tel	Cell	Email address	Signature

N.B. This form (and all other relevant documentation where available) may be completed and forwarded electronically to Gumani.Mukatuni@gauteng.gov.za and please copy (cc) David.Makhado@gauteng.gov.za; Faith.Tshabalala@gauteng.gov.za and ResearchInfo@gauteng.gov.za. The last 2 pages of this document must however have the original signatures of both the researcher and his/her supervisor or promoter. It should be scanned and emailed, posted or hand delivered (in a sealed envelope) to Gumani Mukatuni, 7th Floor Marshal Street, Johannesburg. All enquiries pertaining to the status of research requests can be directed to Gumani Mukatuni on tel. no. 011 355 0775.

Other Information:

i) On receipt of all emails, confirmation of receipt will be sent to the researcher. The researcher will be contacted via email if any documents are missing or if any additional information is needed.

ii) If the GDE Research request submitted is approved, a GDE Research Approval letter will be sent by email to the researcher as well as the Supervisor / Lecturer / Promoter. Please ensure that your email address is correct.

iii) After successful completion of your research, please send your Research Reports / Thesis / Dissertations and GDE Research Summaries (on the template provided to both the Researcher and the Supervisor with the GDE Research Approval letter) to the same addresses as the GDE Research Request documents were sent to, namely: Gumani.Mukatuni@gauteng.gov.za and copy David.Makhado@gauteng.gov.za ; or Faith.Tshabalala@gauteng.gov.za and ResearchInfo@gauteng.gov.za.

APPENDIX C: CONSENT FOR PARTICIPANTS (TEACHERS)

UNISA | college of education

PARTICIPANT INFORMATION SHEET – Consent letter

Date : April 2018

Title: The Influence of Smart board on the Teaching and Learning for Physical Science Grade 12 learners.

DEAR PROSPECTIVE PARTICIPANT

My name is Mosima Tefo and I am doing research under the supervision of Dr AR Molotsi, a Senior Lecturer in the Department of Science and Technology towards a M Ed at the University of South Africa. We are inviting you to participate in a study entitled: The influence of smart board on the teaching and learning of Physical Science grade 12 learners.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could lead to the maximum use of the smart board for teaching and learning of Physical Science Grade 12 learners.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are a grade 12 Physical Science teacher who uses a smart board for teaching and learning as informed by the principal of your school.

One teacher will be interviewed from four different schools in Gauteng, Tshwane North District.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves audio recording of semi structured interviews. The expected duration of the interview will be 45min per teacher and there will be an observation of the Physical Science class. After observation, eight to ten learners will be interviewed as a focus group. Focus group interview with learners will take 30-40min.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The study will create awareness for all educational stakeholders about the benefits and challenges of using a smart board for teaching and learning of Physical Science Grade 12.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There is medium risk since human participants are involved. Grade 12 Physical Science teachers and Grade 12 Physical Science learners will be involved in the study. Since the learners are under 18 years their parents will give consent as a mitigation for the risk.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

The research finding will be presented in a research report, journal articles and/or conference proceedings. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report. It is sometimes impossible to make an absolute guarantee of confidentiality or anonymity but every progress will be reported to the Ethics committee.

Focus group is a data collection instrument used to collect data after participant observation and in depth interviews and it involves 8-10 participants with characteristics related to the purpose of the research, (McMillan & Schumacher 2010:363). In this study the focus group will be Physical Science grade 12 learners from identified schools. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially. I shall, however, encourage all participants to do so. For this reason I advise you not to disclose personally sensitive information in the focus group.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at Unisa offices for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer and from the recycle bin.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Your involvement is this study is voluntary. No compensation will be given to participants. The study will be towards a Master's in Education qualification.

HAS THE STUDY RECEIVED ETHICS APPROVAL

This study has received written approval from the Research Ethics Review Committee of Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mosima Tefo on 0827498395 or email simitefo347@gmail.com. The findings are accessible for one year after the study has been completed. A report will also be sent to the Tshwane District as it is requested on the approval letter.

Should you have concerns about the way in which the research has been conducted, you may contact Dr AR Molotsi at molotar@unisa.ac.za or 0124293265.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

_____

Signature

_____

Mosima Tefo

APPENDIX D: SIGNED PERMISSION LETTERS – PRINCIPALS

UNISA college of education

Request for permission to conduct research at Saulridge Secondary School

Title of the research: **The Influence of Smartboard on the Teaching and Learning of Grade 12 Physical Science in Tshwane District.**

Date: May 2018

The Principal
Department of Education

Dear Sir/Madam

I, Ms Mosima Tefo am doing research under supervision of Prof Maria Jakovljevic, towards M Ed degree at the University of South Africa. We are inviting you to participate in a study entitled '*The influence of smartboard on the teaching and learning of Grade 12 Physical Science in Tshwane District*'.

The aim of the study is to investigate the influence of smartboard on the teaching and learning of Physical Science Grade 12 learners.

Your school has been selected because it uses smartboard to teach Physical Science grade 12 learners.

The study will entail observing one lesson, focus group and semi-structured interviews of teachers at four different schools using the smartboard in Tshwane District.

The benefits of this study are to promote the use of smartboard at schools should they be found to be beneficial.

There are no potential risks.

There will be no reimbursement or any incentives for participation in the research.

Participants can call Mosima Tefo on 0827498395 for a feedback.

Yours sincerely,

Mosima Tefo

Researcher

APPENDIX E: CONSENT RETURN SLIP

UNISA | college of education

CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understand the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interviews.

I have received a signed copy of the informed consent agreement.

Participant Name and Surname (please print)

_____

_____ _____

Participant Signature Date

Researcher's Name & Surname **Regina Mosima Tefo**_____

_____ _____

Researcher's signature Date

APPENDIX F: ASSENT LETTER FOR LEARNER

UNISA | college of education

LETTER REQUESTING ASSENT FROM LEARNERS IN A SECONDARY SCHOOL TO PARTICIPATE IN A RESEARCH PROJECT

Title of your research: **The Influence of Smartboard on the Teaching and Learning of Grade 12 Physical Science in Tshwane District.**

Dear _____

I am doing a study on the influence of smartboards on the teaching and learning of Physical Science grade 12 learners as part of my studies at the University of South Africa. Your principal has given me permission to do this study in your school. I would like to invite you to be a very special part of my study. I am doing this study so that I can find ways that your teachers can use to facilitate learning better. This may help you and many other learners of your age in different schools.

This letter is to explain to you what I would like you to do. There may be some words you do not know in this letter. You may ask me or any other adult to explain any of these words that you do not know or understand. You may take a copy of this letter home to think about my invitation and talk to your parents about this before you decide if you want to be in this study.

I would like to ask to interview you about a Physical Science lesson delivered via smartboard. A group of 8-10 participants will be involved in an interview as a focus group. Focus group will take 30-40min.

I will write a report on the study but I will not use your name in the report or say anything that will let other people know who you are. Participation is voluntary and you do not have to be part of this study if you don't want to take part. If you choose to be in the study, you may stop taking part at any time without penalty. You may tell me if you do not wish to answer any of my questions. No one will blame or criticise you. When I am finished with my study, I shall return to your school to give a short talk about some of the helpful and interesting things I may find in my study. I shall invite you to come and listen to my talk.

The potential benefit of the study for the teachers will be to develop confidence in using the smartboard technology for teaching and learning and the pedagogy required for teaching Physical Science. Learners will understand abstract concepts much better and interact with the lesson.

There is medium risk since human participants are involved. Grade 12 Physical Science teachers and Grade 12 Physical Science learners will be involved in the study. Since the learners are under 18 years their parents will give consent as a mitigation for the risk.

You will not be reimbursed or receive any incentives for your participation in the research.

If you decide to be part of my study, you will be asked to sign the form on the next page. If you have any other questions about this study, you can talk to me or you can have your parent or another adult call me at **0827498395**. Do not sign the form until you have all your questions answered and understand what I would like you to do.

Researcher: Mosima Tefo **Phone number: 0827498395**

Do not sign the written assent form if you have any questions. Ask your questions first and ensure that someone answers those questions.

WRITTEN ASSENT

I have read this letter which asks me to be part of a study at my school. I have understood the information about the study and I know what I will be asked to do. I am willing to be in the study.

_____ _____ _____

Learner's name (print): Learner's signature: Date:

_____ _____ _____

Witness's name (print) Witness's signature Date:

(The witness is over 18 years old and present when signed.)

_____ _____ _____

Parent/guardian's name (print) Parent/guardian's signature: Date:

_____ _____ _____

Researcher's name (print) Researcher's signature:
Date

APPENDIX G: CONSENT LETTER TO PARENTS

UNISA | college of education

LETTER REQUESTING PARENTAL CONSENT FOR MINORS TO PARTICIPATE IN A RESEARCH PROJECT

Dear Parent

Your child is invited to participate in a study entitled The Influence of the Smartboard on the Teaching and Learning of Physical Science Grade 12 learners.

I am undertaking this study as part of my master's research at the University of South Africa. The purpose of the study is to investigate the influence of a smartboard on the teaching and learning of Physical Science grade 12 learners and the possible benefits of the study are the improvement of teaching and learning Physical Science grade 12 learners. I am asking permission to include your child in this study because he/she is a grade 12 Physical Science learner. I expect to have 8-10 other children participating in the study.

If you allow your child to participate, I shall request him/her to:

- Take part in a focus group interview. A group of 8-10 learners will be interviewed as a group after a Physical Science lesson was presented using a smartboard. The interview will be at the school premises. The interview will take 30 to 40minutes.

I would like to request permission to record the learner's responses using a voice recording.

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and will only be disclosed with your permission. His/her responses will not be linked to his/her name or your name or the school's name in any written or verbal report based on this study. Such a report will be used for research purposes only.

There is medium risk since human participants are involved. Grade 12 Physical Science teachers and Grade 12 Physical Science learners will be involved in the study. Since the learners are under 18 years their parents will give consent as a mitigation for the risk.

Your child will receive no direct benefit from participating in the study; however, the possible benefits to education are that if they use the smartboard it will increase learner participation and understanding of abstract concepts.

Neither your child nor you will receive any type of payment for participating in this study.

Your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusal to participate will not affect him/her in any way. Similarly you can agree to allow your child to be in the study now and change your mind later without any penalty.

The study will take place during regular classroom activities with the prior approval of the school and your child's teacher.

In addition to your permission, your child must agree to participate in the study and you and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation in the study will be stored securely on a password locked computer in my locked office for five years after the study. Thereafter, records will be erased.

If you have questions about this study please ask me or my study supervisor, **Prof Maria Jakovljevic**, Department of Science and Technology, College of Education, University of South Africa. My contact number is **0827498395 and my e-mail is teform@unisa.ac.za**. The e-mail of my supervisor is **jakovm@unisa.ac.za**. Permission for the study has already been given by GDE and the Ethics Committee of the College of Education, UNISA.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. You may keep a copy of this letter.

Name of child: _____

Sincerely

_____ _____ _____

Parent/guardian's name (print) Parent/guardian's signature: Date:

_____ _____ _____

Researcher's name (print) Researcher's signature Date:

APPENDIX H: INTERVIEW PROTOCOL

An Interview Protocol

Topic: **The influence of the Smartboard on the Teaching and Learning of Grade 12 Physical Sciences in Tshwane District**

Introduction:

My name is Mosima Tefo and I am doing research under the supervision of Prof Maria Jakovljevic a professor in the Department of Science and Technology towards M Ed at the University of South Africa. We are inviting you to participate in a study entitled: *The influence of smartboard on the teaching and learning of Physical Science grade 12 learners.*

What Should An Interview Protocol Contain?

a. Instructions to the interviewer

You are invited to this interview because you are a Grade 12 Physical Science teacher who uses a smartboard for Teaching and Learning as informed by the principal of your school.

The expected duration of the interview will be 30min per teacher. and there will be an observation of the Physical Science class. After observation, eight to ten learners will be interviewed as a focus group. Focus group interview with learners will take 30-40min. The information obtained will be used for research purposes and no names of participants will be used.

Participating in this study is voluntary and you are under no obligation to consent to participation. This interview will be recorded using an audio recorder. This will assist the researcher when transcribing for data analysis purposes.

The researcher will also take some notes during the interview. Follow up questions maybe asked during the interview for clarity.

Are there any questions before commencing with the interview?

b. The questions are:

- How long have you been teaching Physical Science grade 12 classes?
- Did you receive any training on the use of the Smartboard?
- What are the advantages of using a smartboard?
- What are the disadvantages of using a smartboard?
- How does the integration of the smart board benefit learners?

APPENDIX I: FOCUS GROUP QUESTIONS

UNISA college of education

Focus group questions

Topic: **The Influence of the Smartboard on the Teaching and Learning of Grade 12 Physical Science in Tshwane District**

Instructions:

- Participation is voluntary
- Allow other learners to respond to questions
- Participants' responses will be recorded on an audio recorder
- The researcher will also take notes
- The names of participants will not be included in the report

Focus group questionnaire for learners:

1. What is your view of learning through the smartboard?
2. How well does the teaching style used on the smartboard benefit you?
3. What are the advantages of smartboard and tablet for learning?
4. What are the disadvantages of learning through the smartboard and tablet?
5. What do you think could improve the use of the smartboard and tablets for teaching and learning?

APPENDIX J: FOCUS GROUP ASSENT

FOCUS GROUP ASSENT AND CONFIDENTIALITY AGREEMENT

I_____ grant assent that the information I share during the focus group may be used by Mosima Tefo for research purposes. I am aware that the group discussions will be digitally recorded and grant consent/assent for these recordings, provided that my privacy will be protected. I undertake not to divulge any information that is shared in the group discussions to any person outside the group in order to maintain confidentiality.

Participant's Name (Please print): _____

Participant Signature: _____

Researcher's Name: (Please print): _____

Researcher's Signature: _____

Date: _____

If you are and adult who gives permission you **consent** then delete assent

If you are a learner who gives permission you **assent** and then delete consent

APPENDIX K: TEACHER INTERVIEW QUESTIONS

Topic: The Influence of the Smartboard on the Teaching and Learning of Physical Science Grade 12 learners.

Teacher interview questionnaire

1. How long have you been teaching Physical Science grade 12 classes?
2. Did you receive any training on the use of the Smartboard?
3. What are the advantages of using a smartboard?
4. What are the disadvantages of using a smartboard?
5. How is the intergradation of the smartboard beneficial to learners when teaching Physical Science?

APPENDIX L: OBSERVATIONAL PROTOCOL

UNISA | college of education

Observation Protocol

Topic: The Influence of the Smartboard on the Teaching and Learning of Grade 12 Physical Science in Tshwane District , Gauteng Province

Teacher Name: Ms Kgwadi School: Saulridge District: Tshwane

Date of Observation: 17/05/2018 Time In: 10:00 Time Out: 11:05

Grade: 12C Total Learners Present: 38 Observer: Mosima Tefo

Self-awareness: Abilities competent in P.S Strength Interactive Skills _____ Weaknesses —

Social skills: Discussion ✓ Roll play _____ Feedback ✓ Lesson objective: Chemical Equilibrium

Criteria	Not Observed	1 Slightly Used	2	3	4 Very Prominent	Comments / Additional notes
A. Learners attitude towards learning						
1. Learners participating fully during the lesson				✓		
2. Learners have ICT skills				✓		
3. Learners are prepared for the lesson				✓		
4. Learners are disciplined						
B. Learners behavior while learning						
1. Learners are cooperative					✓	
2. Learner completes task on the allocated time						
3. Prompt action is taken to address poor behavior						
4. Learners are focused and not destructed by the smartboard					✓	
C. The goals of the class activities						
1. Lessons objectives are outlined		Chemical reaction			✓	
2. Teaching material are appropriate for the lesson						
3. Teacher allows enough time for activities		Rate and extended reactions ✓				Time to complete class work was not given to the students
4. Teachers monitors completion of activities						
5. Teacher provided support during correction of activities		Chemical equilibrium			✓	
6. Learners engage with the smartboard	✓					One learner was asked to work on the smartboard

APPENDIX M: DATA TRANSCRIPT

Teacher Interviews:

Teacher	Teacher 1	Teacher 2	Teacher 3	Teacher 4
How long have you been teaching Physical Science grade 12 classes?	3yrs	3yrs this year	From 2014 4yrs	Actually am from Zimbabwe, so I have been teaching for 11 yrs in South Africa. I have been teaching Physical SA science and Maths.
Did you receive any training on the use of the Smartboard?	Yes we did They just came in once. It was not easy but we are learning every day.	Yes From the district? Yes it was from the district How long was the training, one week or two days? 1 week and 2 days Do they give you support:	Yes How long was the training It was a day	Yes very much. Almost two years. There is training. But then , I am not sure . It is Mr Mashiane , previously it was Jerry. Whenever we have challenges we call them.
When you encounter challenges what do you do?		They send interns to come and help	I always ask learners to help	
What are the advantages of using a smartboard?	We don't write a lot . As teachers it is easy for us	Save time You can save information. Rather than erasing the	In terms of preparations I manage to prepare at home and use the memory	Very many. They are endless. The smartboard. If you were used to the

		information especially for the slow learners are able to get the information later Learners are able to understand when they look into videos, video clips We are able to put, video clips,(Oh) just like television Where they taught us they have data. You could even get into the internet and find information quicker. The smartboard does not have data but in the school, they have installed free wifi outside. Is it big enough to download the videos? No it is not. We even test if they have installed wifi We did not test if it is working this side. They said they will out it but	stick to project	chalkboard, you will love the smartboard, no more duster or chalk You can erase with your hand. You can open different pages You can save what you have written You can put a usb, connect a laptop and save the work Anything you want you can connect to the smartboard and teach the learners. It also comes with some software which you can use And some icons which you can use to enhance your teaching.
What are the disadvantages of using a smartboard?	I think number one: Learners you are not sure, have to go around and see if they are writing	Sometimes it freezes. I you have double period it is lost Then your time will be lost.	The electricity Any other disadvantages.	Well they are not many. Maybe when there is no electricity we have a backup of a white board.

	Like they enjoy as if they are watching TV some, they are so relaxed , some they don't write They are still shocked or what? I don't know. Secondly, sometime you try to switch on the smartboard , it freezes. When there is no electricity ,there is no way you can teach.	When you call the people to come and fix If it is not properly supervised, then learners use it for their own purposes. They play it. (Mmhm,)they are watching movies.	No it's the electricity. I there is no electricity there is a problem with learning	If there is no electricity We never had it breaking down or virus because they are being cleaned regularly. I can say there are no disadvantages.
		Hmm so if teachers are not there in the class you need to lock it? Yes you need to lock it.	How does the integration of the smartboard benefit the learners? For them? Do you see them improving or is it the same as the chalkboard? It the same . I don't see any improvement.	
Tablets	The tablets, they have stopped them because they disturb learners. Learners they don't use them efficiently for school they use them for other			

	things, always there on their thing called what?			

	Their thing, the wifi. When you tell them to come to class , they tell you they are doing assignments. Some of them are no more working.			

How does the integration of the smart board benefit learners?	I think like other pictures, they help them because we cannot draw them. When you see, I realised that when you see something, it stays in the mind unlike when they see somethings. When they see the picture , it stays a long time in the mind of the child. Picture, helps them. They are drawn correctly. Like momentum, the child does not know it it is a car or a human being. We are able to google something that you are able to put there. I can save it on a memory stick .Then fit it on the smartboard. Like the Maxwel curves, I didn't get time to do them. Those curves	To me they are able to see and to get enough information that the need. Because it also has textbook. Resources. Now that they steal them how do you manage for the rest of the year? Ja, they usually steal them during the school holidays.(Joh) Last time what we see the principal, I think they talk to other teachers like Mr Maake would collect them and take it home and bring it back when we reopen. That is the only way they which can be protected. Unless. This area, the crime rate is too high.		The learners benefit a lot. It is something that is technological, soft touch. They are so eager to use it. It make the learning process easier because they want to get involved. You can show videos, content videos and they hear a different voice and it enhances their concentration as well. So you see it is very beneficial for our learners.
Experiments: are you able to do experiments on the smartboard?	I did the practical. I am not sure about the smartboard. I normally do them practically on the lab	The learners, can they use the smartboard? Yes I think they are able to	What about the experiments, are you able to do them on the smartboard?	Of late I have not done any myself but it is possible. You can look for a video whereby an experiment is

		use the smartboard. But in the school , they are not allowed to touch the smartboard without the teachers permission. Remember they were given the tablets, (Ja) Because you will show them the question papers and they will slide them on their tablets. So it works well if they have the tablets. If they don't have the tablets, lets say I am giving them information it's like I am giving them information form the chalkboard now because they need to write. Now it is no longer saving that time that we re talking about. Activities , are they able to finish on time? No most of them are very slow. Unless you are there to supervise them. Usually I say , I am going to collect your books. When I say that they know they must finish cause I am going to collect their books.	No They are not loaded on the smartboard? No . Usually when we do experiments we go to the laboratory so in the laboratory we do not have the smartboard. Don't you have pre-recorded ones? I don't know. The smartboard does not have? No	been done. They can use it to observe when they are doing the practical part .

What can be done to improve the services of the smartboard.	Number 1 ; Antivirus, sometime it tells you it has a virus. Why don't they connect them to the internet, so that our work is much easier. Because if it has everything, there is no need to bring the memory stick. Maybe I save my work there. I type in the staff room and save on the email. When I get to the smartboard, I am able to open them them there to avoid issue of memory stick in and out. Concerning the electricity issue, there is no way they can control it.			Do you have an internet around the school where you can download those video? Our internet is to be connected because we are meant to be having wifi in each classroom. It is not connected as of now.
Generator?	I don't know. If they can afford generators. About electricity I don't know what to say because they say the switches that side are not working. Like those in grade 11. They are not working now due to the electricity problem.			When were the smartboards installed? This year in February. This year? Yes this year
Like when you compare	Yes I prefer the	Ya I think there is a huge		

the chalkboard era and the smartboard	smartboard. I wish they can try to improve on the issue of the virus. Because the smartboard freezes. You end up not wanting to use it. That is why when I go to class you see, I carry my lesson plan, I print it because it can jam. So when it jams I write. But it is very nice. It makes you to be clean and rest from using chalk. You become smart	change. Although for the first time , you need to prepare lessons. It takes much time, you don't see the difference. But for the second year you see the difference because you just plug the notes to show the learners.		
That lesson plan. Did you create it yourself?	No I created it myself and used memory stick to load them on them there.	The previous one used to give us lesson plans, but this one he does not give. The current facilitators wants us to prepare our own lessons which takes more time on preparation. You can use the same lessons.		

Focus group interviews:				
	School A	**School B**	**School C**	**School D**

What is your viɒugh the learning smartboard?	We can see the thing that they teach, we are not just imagining them. It enhances our education. It's time for technology. Now we took a photo of the homework. We did not waste time. It saves on time It has facebook inside We don't carry text books that are heavy. We use them at home as reference .They will not get lost	We can watch videos Its more practical than learning using a smartboard We can be able to get more out of it than using the book. We can save our work on the smartboard Are you able to write like the teacher does. Yes when we do correction with the teacher. Do they allow you: Yes	I think it's and advantageous because the others can learn using visualising and others can use pictures to see whats happening There are times where teachers cannot draw a picture or give you the same structure.	It makes work simpler. And we have more knowledge like when we use technology. It makes it easier for us to use the smartboard. Also it enhances or advances the system fo education, looking at the country and going global. It's easier for us to relate to what ever is being taught there because now instead of going long draai, we are able to check the question paper. So it helps with our level of understanding. And with multitasking.
How well does the teaching style used on the smartboard benefit you?	The style is visual learning There are other people who believe things when they see them. They use their imagination	It is more quicker than a smartboard Text books? The smartboard has text book. Its hard to carry 7 text books. So we are able to use the textbooks ard has books	Its does not really benefit us because they don't write notes as they used to to being notes. The other are slow. The slides, like we are not able to gather all information.	It helps. How? Like last year when we were using the chalkboard, we could not be exposed to question papers. You find that you get to the exams and you are not used to the question paper. You become nervous.

				And that lowers your self – esteem. But now, that we can see the question papers when you to the exam you enter being ready because you are used to the question papers.
What are the advantages of smartboard and tablet for learning?	Saves time More resources No more chalkboard	To save notes. We use them when we need them. We use them whenever we need them. They use the different colours when they write . The brain can remember the colours. They Without the teachers we are able to play videos that we downloaded that can benefit us. Whose downloading the videos: Ourselves And the question papers. We do use the smartboard alone but we ask for the teachers permission. The	They have extra material that we can use to get information.	Like the smartboard they have question papers. There are more videos and we communicate with teachers using the tablets. And the textbooks. We find recordings inside the tablets. When we do experiments in class you can take a record using the tablets.

		person who went to the teacher will be responsible		

What are the disadvantages of learning through the smartboard and tablet?	Some teachers cannot use the smartboard They are not computer literate No electricity no learning No generator to back it up It increases the rent of the school , the rent They tell us It still uses current when we are talking School children listen to things that are not for school There is supervision Sometimes there is no signal Sometimes teachers are too fast Where do they get the videos- they down load them and play themselves	It freezes, Not regularly. The learners stop using it for school things but they watch movies It affects learners in a negative way because when he connect to the laptop they move fast because some learners are slow its like they are watching a biskop. Tablets ? No they steal them and others did not return them	We can't see clearly. My eye sight. We cannot all just come to the front. Some of us cannot see clearly But it is big screen why can't you see? The brightness is too much Even today, there is no electricity. So there is no teaching.	More learners nowadays they are taking advantage because they have tablets they put their games and videos. It depends on you how you want to use it They give tablets from grade 8-12 but the people. Learners from grade 8-11 they don't use it for educational purpose. But they have them? Yes They use it for games, whatsapp etc. People steal our tablets If there are blackouts around the community, we are not be able to use the smartboards. But we have the whiteboards at the back. But it is slow.

	They have downloaded even school videos			
What do you think could improve the use of the smartboard and tablets for teaching and learning?	The smartboard should work with the teachers fingerprint Tablets must have the learners finger print Train teachers to use the smartboard.	Insert data on the smartboard Improve sound quality when they play videos. It plays louder Graphics. It must be in high quality graphics. What the teachers bring and the work done The figures must be visible	They should give us the tablets since we are using electronics. We will be bale to get that information from the smartboard to our tablets. I think the goggle should be able to work we can do research. Why are they not giving you tablets : They say there is a delay in ITC , ICT.	More content to be added They should not give up to the grade 12, 11. But they should learn. But they are misusing them. If you can come mam on Monday you will see that these tablets But for us matriculates, they are useful. If they can check the pass rate individually. The pass rate is quality then they can have the smartboard. The grade 8's do they have smartboards down there? Yes every class. Are the teachers having smartboard down there? Yes. Then why Why were you not using the tablets in class. You cannot use tablets and while listening to the teachers.

				So are they tablets used at home? Yes. It is for home works and question papers. If you want to write something down you can take a picture.
Can you use the smartboard	Yes we can operate it . We can also play the videos We can use it only after school but under supervision The lower grades check the teacher and play naughty videos We need to change their mind set Why not download videos-	Is learning improving: Sometimes because we miss notes like in the smartboard Learning has improved. The teacher can write on the board. Whe she is tired – they call the next class which will copy things they do not understand fast. Some learners learn using the videos, some prefer notes and others a practical Some are able to record that in their minds for learning purposes		
Tablets	Some got stolen Some damaged They sell them			Did you get tables? Yes

Crime	They steal them to use as phone Some sell them in Malawi The mentality of the black person.			Thye should increase the security because learners are hacking the smartboards for personal uses
			Do you enjoy your science class? No I do not enjoy it. Why? Through my teachers, I do enjoy it but through my class mates I don't enjoy. Why?	

Observation protocol:

Criteria	School A	School B	School C	School D
Lesson objectives	Chemical Equilibrium	Chemical Equilibrium	Acids and bases	Chemistry Revision
Time	10:00 -11:00	15:0-16:00	11:45- 13:15	13:20-15:00
Number of learners	38	25	22	15

Self-awareness: **Abilities**	**Allows students to engage with smartboard and creates lesson plans on line**	**To create lesson**		**Ability to explain concepts and page from one smartboard slide to another**
Strength	**Is comfortable with the class and has a good sense of humor**	**Have patience with learners**	**Have a good sense of humor**	**Works well with the students**
Skills	**Competent with the smartboard**	**Smartboard skills**		**Good smartboard/ICT skills**
Weaknesses	**None**	**None**	**Lesson objectives not stated** **Not competent with the use of the smartboard**	**None**
Social skills	**Lesson objectives displayed** **Gave learners feedback for homework given** **Engaged in discussion over the lesson**	**Discussion of the lesson**	**Feedback given for homework**	**Lesson objectives were stated** **The students engaged in discussion during the revision lesson** **Teacher provided feedback on activities done on the question paper.**

A. Learners attitude towards learning				
1. Learners participating fully during the lesson	Prominent	Prominent	Prominent	Prominent
2. Learners have ICT skills	Slightly	Not observed	Slightly	Very Prominent
3. Learners are prepared for the lesson	Prominent	Prominent	Prominent	Prominent
4. Learners are disciplined	Prominent	Very prominent	prominent	Very prominent

Comments / Additional notes		Learners did not interact with the smartboard	Learners are able to switch on the smartboard	

B. Learners behavior while learning				
1. Learners are cooperative	Very prominent	Very prominent	Prominent	Very prominent
2. Learner completes task on the allocated time	Slightly prominent	Not observed	Prominent	Very prominent
3. Prompt action is taken to address poor behavior	Prominent	Not observed	Used	Prominent
4. Learners are focused and not destructed by the smartboard	Prominent	Prominent	Prominent	Very prominent
Comments / Additional notes	Learners seem comfortable when being taught from the smartboard. They cooperated very well with the lesson. The task was given the previous day as a homework and all of them completed it	Learners were doing revision and engaged with activities together with the teacher	Learners are behaving but arrive late for class	
C. The goals of the class activities				
1. Lessons objectives are outlined	Very prominent	Very prominent	Prominent	Prominent

2. Teaching material are appropriate for the lesson	Prominent	Very prominent	Prominent	Very prominent
3. Teacher allows enough time for activities	Prominent	Not observed	Prominent	Very prominent
4. Teachers monitors completion of activities	Prominent	Not observed	Slightly observed	Very prominent
5. Teacher provided support during correction of activities	Very Prominent	Very prominent	Very prominent	Very prominent
6. Learners engage with the smartboard	Prominent	Not observed	Slightly used	Prominent
Comments / Additional notes	Learners were not given time to complete the classwork. One learner engaged with the smartboard when he was switching it on	Teachers summarised the lesson using the smartboard pens and drawing of sketches	Learners only corrected homework The engages with the smartboard when they switch it on when class begins	

D. Instructions used in the classroom 1.Prompts students to participate 2.Teacher shows knowledge and	Very prominent	Prominent	Prominent	Prominent

understanding of the subject matter 3.Teacher uses scientific language 4.Instructions used captures the interest of the students 5.Teacher uses different teaching techniques during the lesson	Very prominent Very prominent Very prominent Very prominent	Very prominent Very prominent Prominent prominent	Very prominent Very prominent Prominent prominent	Very prominent Very prominent Prominent Slightly prominent
Comments / Additional notes		Teacher used smartboard and textbook. stion He also used que answer method to facilitate learning	Uses question and answer method Teacher used textbook	Teacher uses question and answer method

Additional comments	Students engaged with the lesson Teacher used smartboard in conjunction with the smartboard and exam guideline form the DoE Learners were not using tablets	Teacher used smartboard, especially the pens He used the study also as a teaching aid He used question and answer method to	Teacher corrects homework activity with the learners After 15min of observation , there was a power failure. Teacher then used only the	It was a revision session in preparation for the mid year exam the following week. Teacher can change between different slides of the question paper and the worksheet.

	Learners were seated in a group format Teacher used the question and answer method of teaching Learners copied notes on from the summary given by the teacher on the smartboard into their books Activities were on the lesson plan that was presented on the smartboard. Learners do not need to bring textbooks to school to do activities	engage the learners Learners assisted the teacher with technical support when presenting the lesson Lessons were planned on the smartboard and the saves on to the smart board using a usb	textbook and learners work book to continue with the lesson. There is no white board in the class Learners received copies of homework activity.	Learners are allowed to engage with the board as they solve problems There is a white board opposite side of the smartboard. Learners can use different functions of the smartboard such as colored pens.

APPENDIX N: EDITOR'S LETTER

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To whom it may concern

This letter serves to inform you that I have done language editing, formatting and reference checking on the Master's thesis **THE INFLUENCE OF SMARTBOARDS ON THE TEACHING AND LEARNING OF GRADE 12 PHYSICAL SCIENCE IN TSHWANE DISTRICT, GAUTENG** by **Regina Mosima Tefo**

Barbara Shaw

11 August 2020.