**Barriers to high performance in Physical Science among learners: A case of selected Township Secondary Schools in South Africa**

by

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# DECLARATION

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Exact wording of the title of the dissertation as appearing on the electronic copy submitted for examination:

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I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

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

1 OCTOBER 2019

SIGNATURE DATE

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# DEDICATION

I dedicate this work to my loving husband, David Simelane, my children Sabelo and Khwezi Simelane for being patient and allowing me to focus on my study. Thank you so much my family.

## ABSTRACT

The quality of matric results for Physical Sciences in South Africa is very poor and as a result few learners are able to meet the admission requirements to study careers related to Physical Science at tertiary institutions. The study investigated barriers to high performance of Physical Science learners at the township secondary schools in the Tshwane West District, in the Gauteng Province. Using a qualitative approach and a case study design, samples were chosen purposefully involving three secondary schools in the Tshwane West District. The schools that obtained a high pass rate in the Physical Science Grade 12 in the year 2017 were identified. Grade 11 and 12 Physical Science teachers and learners participated in this study. The data were collected by means of semi-structured interviews, and Physical Science lesson observation. The semi-structured interviews were conducted with four Physical Science teachers including Heads of Department (HODs) from the three selected secondary schools and 15 Physical Science learners in Grade 11 and 12. The data were analysed manually. The data were categorised according to themes, and then coded by hand and supported by the literature review. The anonymity of all participants was protected. Upon analysis of the results, some contributory barriers of high performance in Physical Science were identified from the three township schools, and these include inability to finish Grade 12 curriculum in time, parents forcing learners to do Physical Science in the senior grades (particularly in Grades 11 and 12), lack of motivation, learners with a negative attitude towards the subject, poverty, crime and dysfunctional Physical Science laboratories. Recommendations for improvement in the areas identified were provided. The Curriculum Developers of the Department of Education must review the Physical Science curriculum, particularly with the view of reducing the number of topics covered in Grades 11 and 12. Poverty and crime must be attended to as learners cannot learn when they are hungry and in an unsafe environment. It was also recommended that the Department of Education must assist in provision of resources necessary to teach Physical Science efficiently.



KEYWORDS: Barriers, high performance, Physical Science, STEM, township schools

## LIST OF ACRONYMS

| | |
|---|---|
| ACC | Academic Competition Council |
| CAPS | Curriculum and Assessment Policy Statement |
| CRS | Congressional Research Service |
| DoE | Department of Education |
| DoBE | Department of Basic Education |
| FET | Further Education and training |
| IQ | Intelligence Quotient |
| K -12 | Kindergarten through 12th Grade (US) |
| KZN | KwaZulu Natal |
| MEC | Minister of Education |
| MST | Mathematics Science and Technology |
| MOSTI | Ministry of Science, Technology and Innovation |
| NCTM | National Council Teachers of Mathematics |
| NCS | National Curriculum and Assessment Policy Statement |
| NOS | Nature of Science |
| NRC | National Research Council |
| PCAST | Presidents' Council of Advisors |
| PISA | Program for International Student Assessment |
| SACE | South African Council for Educators |
| SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) | Science, Technology, Engineering and Mathematics |
| S & T | Science and Technology |
| TIMSS | Trends in Mathematics and Study Science |
| UK | United Kingdom |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| US | United States |
| USA | United States of America |
| | |

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# CHAPTER 1

# INTRODUCTION AND BACKGROUND

## 1.1 INTRODUCTION

The social set-up of South African schools is economically heterogeneous and they serve average to very rich communities (city/urban areas). The Physical Science teacher is a creator of effective educational environments for learning while teaching (Hernandez, Bodin, Elliot, Ibrahim, Rambo & de Miranda; 2013).

With regards to performance of South African Physical Science 2016 matric learners' results, the Minister of Basic Education, Mrs Angie Motshekga reported that there was an increase from 58.6% to 62% in Physical Sciences. However, the quality of these results was poor as she said 3.7% of pupils (7,043 pupils) who wrote the Physical Sciences paper received a distinction (DoBE, 2017). The percentages showed that there are very few learners who will qualify for careers that are related to Physical Science at universities. I have also noticed a decline in performance of learners in Physical Science soon after the introduction of 30% pass mark in Physical Science (assessment policy) and very few high school learners are meeting the university admission requirements. It is important that the South African Department of Education (DoBE) develops a better strategy to improve the performance of South African Physical Science learners.

There is a growing concern about the declining performance of South African learners in Science, Technology, Engineering and Mathematics (STEM) subjects. According to the DBE, South Africa produces few students in STEM every year (DBE, 2011). The Minister of Science and Technology of South Africa, Ms Naledi Pandor, at the United Nations Educational, Scientific and Cultural Organisation Africa Engineering Week at the University of Johannesburg said that the shortage of engineering professionals means that we do not have enough practitioners available for ongoing work (Pandor, 2014). Consequently, the work that requires engineering decisions is being done without competent engineering input.

In 2001, the South African DBE launched a strategic plan for improving Maths and Physical Science education called the Dinaledi School's project. The project was aimed at developing and promoting the scarce skills needed by the South African economy (Kriek & Grayson, 2009). The Dinaledi Schools project was also aimed at increasing the number of Grade 12 Mathematics and Physical Science learners with university-entrance pass endorsement. The programme identified schools according to the number of learners doing Mathematics and Physical Science and the performance of learners. The target group was Physical Science and Maths learners from Grade 10 to 12. Although my school benefitted from the project, the number of Grade 10 Mathematics learners declined significantly after the introduction of Mathematics literacy. For schools to participate in the programme, a minimum ratio of 3:2 for Mathematics and Mathematical literacy had to be met (DoE, 2008), and my school could not meet this requirement. Although the few schools that participated in the Dinaledi programme produced good results, the contribution of the programme to matric pass rate nationally was insignificant. The programme was expensive to run, and therefore only a few schools participated. Because of this, the government could no longer run the project, and the funds were diverted to improve infrastructure (e.g. toilets) at poor-resourced schools. The Dinaledi Project was then handed over to the private sector (DoE, 2009).

The challenge facing education in South African township schools is the shortage of qualified teachers to teach Mathematics and Physical Science. According to the Newspaper (The Star, 5 June, 2012), a high number of South African teachers who qualified to teach Mathematics and Physical Science migrate to the UK (United Kingdom). The country is now dependent on teachers from other countries such as Zimbabwe, Namibia, Ghana, Uganda, Nigeria, Kenya and India.  According to figures taken from the government employee database (Persal, 2011), a total of 3 796, 500, 501 and 90 teachers were from Zimbabwe, Ghana, India and Namibia, respectively. Among these, only 1 286, 975 and 934, were deployed to Gauteng, Eastern Cape and Limpopo, respectively, to teach Mathematics, Physical Science and Technology to pupils from Grades 7 to 12. These figures show that South African schools do not have enough educators to teach Mathematics, Physical Sciences and Technology at Secondary and High school level.

It is important that the South African Department of Education develops a better strategy to improve the quality of Physical Science results in order to meet our country's demands and economy.

## 1.2 STATEMENT OF RESEARCH PROBLEM

Recently, there has been a growing concern about poor performance of South African learners in Physical Science. South Africa produces few learners in Physical Science every year. Reasons for the poor performance range from learners' lack of capacity to write adequate reports, explanations, descriptions, transcode information in speech and writing them into diagrammatic display, and summarising written material for use in examinations or projects.

Recent policy initiatives have focused on teaching Physical Science aimed at promoting knowledge and skills in scientific inquiry, understanding the Nature of Science (NOS) and application of the scientific knowledge (DBE, 2011). Both National Curriculum Statements (NCS) and Curriculum and Assessment Policy Statement (CAPS) documents advocate the use of inquiry-based instruction during teaching as opposed to traditional Physical Science teaching (DBE, 2011). However, the problem with the current teaching of Physical Science is that it fails to reflect the changes in Physical Science that have occurred over the years. Physical Science is still being taught from the perspectives of normal, logical positivism, with more emphasis on the mastery of abstract concepts and principles, and little connection with day-to-day life experiences of learners (Onwu & Kyle, 2011, Mokiwa, 2014).

In township schools the learners are struggling to understand Physical Science as a result they are underperforming as compared to city schools. Based on the statistics of the Preparatory exam 2017 pass percentages of all schools presented by the district director of Tshwane West, most of the township school have barriers to high performance. Most of township school results were very poor compared to city schools and are called Minister of Education (MEC) schools. MEC schools are schools that performed poorly in Matric results, and are supported by the MEC to improve the results. It is hoped that this study will ascertain barriers which contribute to high performance in Physical Science in South Africa, and hopefully recommend possible solutions.

## 1.3 RESEARCH QUESTIONS:

The main and sub research questions follow next.

**Main research question:**

What are the barriers to high learner performance in Physical Science in township secondary schools?

**Sub questions**

- How do learners learn Physical Science in high performing township secondary schools?
- What are the barriers of high learner performance in learning Physical Science in township secondary schools?

## 1.4 AIMS AND OBJECTIVES

**Aims**

The aim of the study was to investigate barriers to high performance in Physical Science among learners in township secondary schools.

**Objectives**

The objectives were to:

- explore how learners learn Physical Science in high performing township secondary schools.
- identify learners' barriers of high learner performance in learning Physical Science in township secondary schools.

## 1.5 RATIONALE OF THE STUDY:

The rationale behind my research project emanates from my personal experience as Science teacher. I have been teaching Physical Sciences for 21 years in South Africa (KZN and Gauteng provinces). Throughout my teaching career, I have noticed that learners coming from urban areas have better understanding of Physical Science than those from rural township areas. Edith, Osagiobare and Unity (2013:152) assert that the learners who have been exposed to poverty have deficiencies in academic capability as formal education is their first point of reference to education. They demonstrated that children from poor families lack intellectual capability (they have a low IQ, a poor vocabulary and limited social skills) simply because they did not get primary education, and this leads to a low vocabulary, IQ, and social skills.

I have also noticed a decline in performance of learners in Physical Science soon after the introduction of 30% pass mark in Physical Science (assessment policy) and very few high school learners are meeting the university admission requirement (meaning getting the bachelors in matric). I have also noticed that the Grade 9 learners are struggling to meet the pass requirements to be promoted to Grade 10, and that most of them are failing to pass Mathematics which is a requirement to do Physical Science in Grade 10. This problem is not unique to South Africa. In Malaysia, for instance, it was reported that lack of Physical Science teachers was as a result of so many secondary school learners who were unable to produce competent Mathematics and Physical Science learners. In Swaziland, they tried to use the Physical Science teacher associations to bring innovations in Physical Science and technology education to improve the Physical Science performance. In Nigeria**,** Physical Science teachers are no longer limited to delivering instruction intuitively, but rather with effective facilitation of learners' activities. Little research has been done to identify the barriers of high performance in township schools for Physical Science in South Africa.

Unlike in countries such as the USA where learners are taught in their mother tongue, the majority of learners in South Africa, particularly blacks, are not taught in their native languages. Teaching in a foreign language could make it difficult for learners to perform well in Physical Science (Mokiwa, 2014). Most teachers have difficulties in explaining Physical Science concepts in a multilingual classroom, and as a result learners find it difficult to understand and apply knowledge in a language that is not their mother tongue. This has motivated me to further investigate the implication of using foreign language in a Physical Science classroom and other barriers that may be contributing to high performance in Physical Science.

The results of the study may help Physical Science teachers to be aware of multilingualism in the classroom as one of the barriers to high performance in township schools and learn how to involve such learners in a Physical Science lesson. Teachers may also need in-service training aimed at improving teaching in a multilingual classroom. The curriculum designers may have to adjust the curriculum in terms of context to favour the multilingual classroom. This study might assist the Physical Science learners to understand the curriculum and perform better. The results of this study could also contribute towards the motivation of learners and their enjoyment of Physical Science. This will, in turn, result in an increase in Physical Science learners' numbers in South Africa, thereby improving the economy of the country.

## 1.6 THE SIGNIFICANCE OF THE STUDY

In this study the researcher investigated the barriers of high performance in Physical Science among learners in township secondary schools. The researcher found out how learners learn Physical Science in high performing township secondary schools and lastly identified learners with barriers of high performance in learning Physical Science in township secondary schools. The three township schools were selected according to their performance in Physical Science.

The study might assist the Physical Science teachers and learners to understand each other more and be motivation to produce high performance Physical Science results at the end of the year. Learning and teaching will be more interesting since teachers and Physical Science learners will have the common goal of producing more level 6 and 7 (70% to 100%).Team teaching will also help to understand how learners in high performing township schools learn Physical Science.

The Grade 12 results might improve since the barriers in high performance will be dealt with and the correct approach will be implemented. The number of learners doing well in Physical Science might also increase. Furthermore, the number of learners studying careers that are related to Physical Science at the university will grow. The South African economy will slightly improve due to an increase in the number of Scientists.

## 1.7 SCOPE OF THE STUDY

The study focused on the secondary schools with a high matric Physical Science pass rate (90%+) in township schools. The Physical Science Grade 12 symbol distributions was analysed, and it revealed that most of the learners are on level 1 (0-29%) to level 4(50-59%). Then the research was conducted in order to identify the barriers of high performance in Physical Science that might contribute to the improvement of quality of results.

## 1.8 DEFINITION OF CONCEPTS

**The Key concepts of the study are:**

**Barriers to learning** are defined in the Department of Basic Education dictionary (DoBE,2010) as the difficulties that arise within the education system as a whole, the learning site and /or within the learner which prevent access to learning and development for learners.
In this study *Barriers* are referred to challenges that hinder the high performance in Physical science as a subject.

**Physical Science**
According to Curriculum and Assessment policy statement (CAPS, 2011), Physical Science is defined as using different approaches of scientific inquiry as well as the applying of scientific models, theories and laws to investigate physical and chemical phenomena. *The Physical Science* in the study is the subject taught at secondary school and used to identify barriers to high performance among the learners.

**Township** is the residential settlement for blacks outside town or city in South Africa (The South African Oxford School Dictionary,2018). In this study *township* was used as the type of the environment where the schools were built, the learners live and learn Physical Science.

According to Department of Basic Education dictionary, a **learner** is a person who attends school. In this study *learners* are those pupils learning Physical science in township secondary schools.

According to Basic Education System, **Secondary schools** are often referred to high schools (grade 8 to 12) in South Africa. The study involved grade 11 and 12 Physical Science learners and their teachers.

**High performance** in the study means excellent results with pass mark of 70-100% in Physical science.

## 1.9 CHAPTER OUTLINE

### Chapter 1: Introduction and background to the study

The main purpose of this chapter was to introduce the topic and offer an explanation of the rationale for this study. Furthermore, this chapter also presents a problem statement, research questions, as well as the purpose of the study objectives. Furthermore, it discusses the significance of the study, scope of the study, chapter division and conclusion.

### Chapter 2: Literature review

This chapter contains a breakdown of the theoretical framework and analysis of literature which is necessary to reach the objectives of this study. The literature reviewed was obtained though Namibian, Zambian, Kenyan, South African and United State of America literature sources.

### Chapter 3: Methodology and Research Design.

The methods used to source the data are explained as well as the methods used to analyse the data are discussed in this chapter. There is also an indication of how the process of choosing samples occurred by describing the sampling methods used.

**Chapter 4: Presentation of the results, the discussion of results and conclusions based on analysis of the results.**

This chapter presents the data acquired through research as well as provides an extensive analysis of the results. The researcher also presents conclusions made based on the results.

**Chapter 5: Presentation of the findings, final conclusions as well as the proposing of recommendations.**

This chapter covers the summaries, answers to research questions and recommendations. A final conclusion is shared.

## 1.10 CONCLUSION

The current chapter served as an introductory chapter to the study by expanding on the background and rationale of this study. The study explored the learning barriers that prohibit South African learners from performing well in Physical Science, and reasons for the neglect of this realm. The observation of poor performance in Physical Science in Tshwane prompted and guided me to deduce that there exists a problem of poor performance in Physical science subject. This observation helped me to outline the aim as well as the research questions that underpinned the study. The research methods used as well as the outline of other chapters are presented in this chapter, this serves the purpose of highlighting how the process of answering the research questions was undertaken. This chapter is preceded by a chapter presenting the review of the literature sourced to assist in answering the research questions.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 INTRODUCTION

This chapter focuses on literature review and theoretical background of the study from South Africa, Zambia, Kenya, Namibia and USA. The qualitative approach is used to find out the barriers to high performance in Physical Science among township school learners in South Africa. According to Thasmai (2013), class size, parental involvement, resources, learner dynamic and curriculum coverage are the factors contributing to poor performance in Grade 12. Research has also acknowledged that the accessibility to and the type of pedagogical facilities (schooling factors), the educational qualifications as well as the economical abilities of the caregivers (socio-economic factors), the attitude towards learning as well the various stimulus to learning(learner-factors) as well the teacher and school type as source for the acquiring of poor marks in Physical science subject i.e. poor performance (Makgato & Mji, 2006; Amukowa, 2013; Mwaba, 2011:2).

The research also alludes to the assertion that if the above-mentioned components that contributed to poor performance were confronted, this confrontation has not been done to the desired extent (Ngema, 2016). Moreover, South Africa is still challenged with poor results in the Physical Science subject at secondary school level. It is possible that there may be other supplementary factors that have not yet been acknowledged, that influence the learner's performance.

## 2.2 FACTORS THAT CONTRIBUTE TO POOR PERFORMANCE IN PHYSICAL SCIENCES

### 2.2.1 Class size and resources

In the study that was conducted in the KwaZulu-Natal (KZN) province, specifically in Pinetown and Ingwavuma Districts in South Africa, it was discovered that the larger the class size the poorer the performance due to time wasted disciplining the Physical

Science learners instead of teaching or conducting the experiments (Yelkpieri, Namale, Esia-Donkoh and OfosuDwamena, 2012:3 27; Mwenda, Gitaar, Nyanga, Muthaa and Reche, 2013:97; Thasmai, 2013:62). In my experience as a teacher, I can attest to the fact smaller Physical Sciences classes are controllable and are easier to teach. I also agree that in most cases lack of resources (e.g., shortage of textbooks or chemicals to demonstrate an experiment) are hampering the abilities of learners to discover the Physical Science concepts on their own.

While the lack of laboratory equipment is believed to have a negative impact on academic performance of learners, few studies conducted in Nigeria have disputed this (Kibirige and Hodi, 2013). These studies indicated that there are no significant differences between academic performance in schools with adequate laboratory equipment and those that lack such facilities but use textbooks (Jebson and Andy 2012). DBE in South Africa has expressed similar sentiments, and has pointed out that the absence of proper school Physical Science laboratories, laboratory apparatus, materials (chemicals and biological specimens) and equipment are no reason for not performing well in Physical Science (DBE, 2003).

Classroom relations between educators and learners include the pedagogy activities, either during lesson in the classroom or a laboratory experiment, that are undertaken by both teachers and learners. According to Fisher (1995:12), successful learning can occur only if there is social collaboration between parents, learners and teachers. Stone (2007:5) states that he experienced exponential difficulty when trying to find and develop classroom tasks that would engage learners mentally and physically during his 21 years of teaching Physical Science. He started by collecting information from text books on practical scientific tasks. Necessary scientific skills such as the ability to observe, analyse, collect data as well as the ability to use data to support and draw conclusions were treated as paramount to learn in these tasks. The acquisition of these skills along with the development of process skills through applications in these tasks were essential in making sure that learners understood every major scientific concept. Stone (2007) emphasized the necessity of pedagogical engagement which is essential for learners to retain scientific knowledge acquired during Physical Science lessons.

According to Farenga and Joyce (1997:248), learners are unique and therefore bring various experiences to the classroom, and that teachers should be able to develop pedagogical tasks upon their existing knowledge and experiences. This means that teachers need to be knowledgeable in their learners existing knowledge and experiences in order for necessary connections to be made with the new knowledge. According to (Kelder 2008:23), teachers can start the grade by developing baseline assessments that will help in assessing the level of understanding learners have of a particular task. An example of these preliminary tasks can be a task developed for assessing a Grade 10 learner's ability to follow instructions of setting up an experiment.

(Ratcliffe, 1998:55) maintains that developing a small-group discussions framework could help with the construction of classroom deliberations is another form of awareness. According to (Ratcliffe, 1998), an arrangement of items that are followed by a number of questions that learners must answer can be a characteristic of the framework. This would help teachers to improve learners' understanding and clarify conclusions. Encouraging learners to highlight the relationship between their scientific education experiences to real problems and the development of social responsibility are other examples of classroom tasks. Teachers must encourage the learners to expand their understanding of the concept as well assist them to improve their understanding through verbalising, listening and developing their own scientific arguments. Organized, thought-based reasoning and analytical skills can also be developed using the framework (Ratcliffe, 1998:57). These extensive processes may produce a good understanding of Physical Science concepts through successful pedagogical engagements between teachers and learners.

### 2.2.2 Challenges experienced during Physical Sciences teaching

Stavy and Tirosh (2000: vii-viii) maintain that studying learners' reasoning and understanding in Physical Science has been the motivation for Physical Science education. They further argue that there has been evidence of these studies being performed in Physical Science education, particularly in the study of Physics. Describing auxiliary ideas and cantering specific content has been the purpose of many research projects. Describing the categorization of concepts as well as resources and relevant approaches to educations would be needed to counteract and correct the known misconceptions, presuppositions and auxiliary ideas that learners have. A foresight into the inappropriate reactions of teachers and learners by researchers and teachers as well the ability to predict and explain the reactions can be acquired through this framework.

Ramnarain and Modiba (2013:65-66) maintain that a revised curriculum proposes a new conceptualizing of scientific reading and writing. They further argue that signifies the need to understand the objectives of the revised curriculum and to develop learning principles that will help them meet these objectives. Ramnarain and Modiba (2013:68) also maintain that most South African teachers have a sense of uncertainty that is a direct consequence of the conceptual shift in the objectives of the ability to read and write scientifically, more specifically, the shift from content specific objectives to broader objectives. Consequently, an unintended consequence of these conceptual shifts has been evident in the level of tenacity teachers have, they maintain that this is due to their inability to meet the objectives of the curriculum predecessor of the revised curriculum. These barriers also affect the teacher’s morale and, in that way, affect the academic performance of learners. The identification and confrontation of specific pedagogical barriers that prohibit teachers from producing the best results is essential as it will assist teachers and researchers in developing possible solutions for these challenges.

In the following section, a few challenges that affect how South African Physical Science teachers perform their teaching are identified, the improvement of these challenges provide good reason.

### 2.2.3 Parental involvement and curriculum

Research also mentioned that parental involvement was lacking and it had a negative effect on teaching and learning, since learners did not do homework (Muzah, 2011:200; Cho, Scherman and Gaigher, 2012:169). However, some parents are trying to assist learners with limited knowledge in Physical Science. Parents need to support their children and communicate with the school. I also agree that learners need support from parents and teachers. For example, parents need to help their children at home with research materials requested by the subject teacher and create a conducive environment to study. They also have an important role to play in motivating their children. Parents should also ensure learners attend school full-time as the completion of the curriculum remains a challenge due to absenteeism of learners at school. Once learners are absent during the lesson, teaching and learning continue in their absence, and thus they fall behind with school work (Muzah, 2011:200; Choet al., 2012:169).

Parents and teachers need to motivate children to go to school and be prepared to work over and above the specified allocated time for the subject per period. The teachers specified that Physical Science concepts require extra time to be explained as learners require more time to grasp all the information (Muzah, 2011: ibid.). Therefore, the time prescribed to Physical Sciences is not enough for teaching and learning. The Cognitive Load Theory maintains that poor learning performance can be attributed to an overload of information that occurs in a short period of time, it also maintains that this can be attributed to the fact that the time taken to processing and storage of new information by the working memory is significantly short. The working memory can only process a few new elements and can store them for a short period of time only (Anthony and Artino, 2008; Merrienboer and Sweller, 2005:148; Kirschner and Paas, 2009). According to Anthony and Artino (2008), if the storage (in schemas) and processing of new information is done by a learner’s working memory, this makes readily available new memory space that will be used to store the new information. It is only after this process has occurred that successful learning can take place.

Many parents have fed into the hierarchy of educational qualifications, and they believe that qualifications that are not acquired through studying at traditional universities are inferior. For example, qualifications such as being an electrician or plumbing diploma or certificate obtained from FET colleges are inferior. Some of them even go to the extent of discouraging their children from applying to institutions that offer technical skills by encouraging their children to rather choose degrees in the humanities. These parents overlook the fact that these degrees do not have a considerable amount of employment opportunities (Castrillon, 2005). The inferior status afforded to FET colleges must be challenged as well as the academic programs that are available at these institutions.

The goals and accomplishments of children are supported by their parents. Parents do this by supporting their children and giving their children an awareness of what they expect of them. It is therefore advisable that parents become more involved in their children's learning through motivation and encouragement as well as regular meetings with the children's teachers.

### 2.2.4 Teacher attitudes

In the Ingwavuma circuit, (Ngema, 2016) discovered that the attitude of teachers needed to be positive in teaching of Physical Science. According to Abudu and Gbadamosi (2014:1035), the influence that a particular situation has on a person's preferences helps in them developing their own idea (attitude) towards an object. They also maintained that attitude can be categorized into being negative, positive and neutral. Barros and Elia (1974) assert that the instruction of a person's sight, hearing, action and thought is determined by the willingness of their mind which they termed attitude. Investigation by Abudu and Gbadamosi (2014:1036) highlight that an important stimulus, which is the presupposed attitude about Physical Science learners hold, propels a learner's performance as well as ideas about the subject.

According to Osborne, Simon and Collins (2003:1054), a good performance in Physical Science can be attributed to having a positive attitude towards the subject. They maintain that this ensures that learners have an interest in the subject and this in turn ensures that learners are assured of and committed to their academic success. According to Abudu & Gbadamosi (2014:1036); Barros & Elia, (1974), research shows that not having a positive attitude as well as the inability to use a straightforward teaching mechanism has a negative influence on a learner's performance. Teachers who are not using the straightforward approach and positive attitude while teaching have an influence on learners having negative attitudes towards Physical Science, and this result in poor performance (Abudu & Gbadamosi, 2014:1036; Barros & Elia, 1974). Attitudes play an essential role in determining learner behaviour towards learning any subjects.

The literature shows that South Africa has a shortage of Physical Science teachers and is a challenge to find a qualified South African Physical Science teacher. According to Modisaotsile (2012:4), every year a large number of Physical Sciences teachers resign from their post in the education sector. According to Hughes (2012:254), some of the common reasons for this alarming rate of teacher's resignation are having extensive work to do as well as earning low wages. Hughes (2012:254) also argues that experienced teachers also tend to opt for early retirement. The SACE (2010:23) maintains the stagnation that occurs in the Physical Science education profession (DOE) also contributes to the resignation of Physical Science teachers. Furthermore, according to James, Naidoo & Benson (2008:2), there is an increase in the employment of teachers who are not adequately trained.

The SACE (2010:23) also maintains that some of the available Physical Science teachers are not well-acquainted with the subject matter and their pedagogical methodologies lack substance. According to Thasmai (2013:18); Makgato and Mji (2006:255), this has a ripple effect because the enrolment levels show a significant decline in the number of learners who are studying Physical Science.

Based on research by Hughes (2012:254), a learner's view of their teacher and their understanding of the subject matter influences their performance in that particular subject. Consequently, another reason for the poor performance of learners is the poor knowledge of the subject matter by underqualified teachers and these low enrolment levels. Hughes (2012:345) further maintains that "experienced teachers are better teachers". I agree with that quote as experienced teachers knows all the possible exam questions, which makes it easier to prepare learners for Matric final exam. The newly appointed teachers find it difficult to teach Matric, but with time they start to understand which approach they must use to get better Physical Science results.

Sanders (2007: 32-38) argues that the creation of an environment that enables successful learning and complement learning styles are important skills that the teacher should have. Furthermore, the teacher should also be familiar with school policies (Curriculum and Assessment Policy Statement). Thasmai (2013:18) argues that a learner's academic performance is also dependent on whether the teacher can keep the learner interested in their subject matter, this coupled with pedagogical skills and subject matter understand is essential in ensuring successful learning.

### 2.2.5 Poverty

Poverty was also identified as one of the factors which contributes to poor performance (Ngema, 2016). According to Lacour and Tissington (2011: 522), poverty is the measurement of how long a person can survive despite a lack of access to resources (social capital, human relationships, emotional support, financial capital as well knowledge). Chinyoka and Naidu (2014:223) argue that the household is a learner's first point of reference to education and the acquisition of other social skills. They further maintain that the academic performance of a learner can also be affected by household environment. Edith, Osagiobare and Unity (2013:152) assert that the learners who have been exposed to poverty have deficiencies in academic capability as formal education is their first point of reference to education. They demonstrated that children from poor families lack intellectual capability (they have a low IQ, a poor vocabulary and limited social skills) simply because they did not get primary education, and this leads to a low vocabulary, IQ, and social skills. This alluded to the assertion that exposure to poverty (lack of access to resources) negatively impacts the academic performance of a learner and results in poor academic performance (Lacour and Tissington, 2011).

Chinyoka and Naidu (2014:223) corroborate this view as they also maintain that poverty prohibits good academic performance. A study by Chinyoka and Naidu (2014:223) shows that the inability of impoverished parents to offer their children assistance with schoolwork is a consequence of their failure to obtain education. Their research also showed that a lack of space in impoverished peoples' houses, their over-crowdedness of these homes results in the unavailability of room for pedagogical engagement between learners and their peers as well as with their parents (Chinyoka and Naidu, 2014:228). Unity, Osagiobare and Edith, (2013: 152) argue that these learners will be unable to study and complete schoolwork due to these conditions. They further argue that impoverishment presents these learners with a lack of emotional support which has a number of negative impact on their academic achievements. These learners then end up channelling this emotional lack into being destructive and being unavailable to develop other social skills due to isolation, depression and social anxiety.

Chinyoka and Naidu (2014:228-230) maintain that impoverished learners also experience exhaustion due their performance of an extensive number of chores at their homes. Furthermore, they argue that this exhaustion coupled with the consequences of the economic migration of their parents, which in return forces them to constantly adapt to new pedagogical environments and methodologies, also leads to their poor academic achievements.

### 2.2.6 Gender discrimination

According to the study conducted by Mwaba (2011) in Zambia concerning the performance of girls in Physical Science, it was revealed that they had a negative attitude towards Physical Science subjects in such a way that they think it is hard and they regarded it as a subject for boys. There are cases when learners dislike learning Physical Science subject because they lack assistance from teachers which result in teachers using poor teaching approach. Moreover, some teachers, especially female teachers, have a negative attitude towards girls as they were expected to focus more on domestic chores than schoolwork. Kelly (1994:54) states that the ideals and single most obvious role that is envisaged for girls are that they would become a wife and mother. Girls are expected to sacrifice themselves from a young age, to prepare for this maternal role. Many view education as a mere interlude in preparing for life and they are raised to believe that education has no relevance once they reach puberty. The low levels of education among women have a bearing on the girls' future economic opportunities. Women lacked such opportunities and thus they end up, in many cases, depending on men for their survival.

Physical Science seems to be disliked by girls as a secondary school subject. Many girls in secondary schools appear to have bad attitudes towards Physical Science as they grow up. That negative attitude occasionally begin in lower grades as their groundwork in Mathematics is generally poor. According to Aiken (1976), this perception of gender variance and behaviour are reflected in Mathematics success that was found to favour males in many studies. Zekele (2001) observes that girls' poor Physical Science accomplishments and attitudes were prominent at the 7$^{th}$, 9$^{th}$, 10$^{th}$ and 11$^{th}$ grade levels. Zekele's finding recommended that these negative attitudes at these grade levels contributed seriously to their performance in Physical Science. Hence, it concluded that Physical Science achievement and attitude towards Physical Science influence each other positively.

Physical Science is not easy to study for most people as it is also real that Physical Science becomes tougher from lower to higher grades. The result of that and perhaps other factors was that girls' attitudes towards Physical Science becomes progressively unconstructive as they progress to higher grades. Meaning that learners would exert increasingly less effort in learning or studying the subject, and the consequences are that their Science achievement would become lower. Swagman (1995) notes that girls' positive attitude towards Physical Science declines as they grow older. Originally girls have a more positive attitude towards Physical Science than boys do, but as they continue in school, girls' attitudes become more negative. Thus, the influence of attitude on Physical Science achievement might be expected to increase from lower to higher grades. The results of Zekele's (2001) research further found that there are other variables besides learner's attitude that have an impact on learners' perceptions of Physical Science. Other variables such as peer-grove expectations were found to affect girls' attitude towards Physical Science and other achievement. From the results both females and males (in grade 8 to 12) thought males do better in Physical Science.

The significance of attitude when learning Physical Science is further emphasised by Harlen (1993:39) who argues that pupils' attitudes affect the willingness of individuals to take part in certain activities, and the way in which they responded to persons, objects or situations. In Grade 7 the only significant sex-related difference in attitude was girls' stronger denial that Physical Science was a male domain. From seventh grade upwards, girls were significantly less confident of themselves as learners of Physical Science. They regarded Physical Science as more valuable, but they regarded it as a male domain. A large study in England was also conducted by peace and surgeon (1980) who evaluated attitudes towards Physical Science among 21 boys and girls aged 13 to 17. They designated that, in general, many of the same patterns of attitude that have been reported in countries like United States can be found in England. For example, where as positive attitude towards Mathematics generally dropped among all pupils, the drop was more dramatic in the case of girls. From these and similar studies it is noted that one of the most significant factors that affect girls' performance was the underestimation of their own ability. They also witnessed that there is some suggestion that girls' relative failure in Physical Science is associated with their approval to regard it as being a male, intellectual domain.

One of the Universities in the USA conducted a study to find out "why students leave engineering majors prior to graduation despite effort to increase retention rates?" (Geisinger, & Raman, 2013). The study found that learners were leaving for different reasons like lack of interest caused by poor career guidance. Other reasons for underperforming in engineering are race- and gender-based causes with women more likely to leave Physical Science than men, partly because they lack similar role models such as peers, teaching assistants, and instructors (Herrmann, Adelman, Bodford, Graudejus, Okun, and Kwan, 2016). Hazari and Potvin (2005) state three perspectives usually held by Physicists, Science education researchers, and the broader community. Each perspective developed from literature on philosophies surrounding the barriers accountable for the underrepresentation of women in Physics. In South Africa, Physics is part of Physical Sciences that at matric level it is normally called Physical Science paper one. The three perspectives are irreplaceable to consider alongside Kelder's (1985) notion of a gendered Science, because they reveal the socially constructed and historical association of male and scientific world. These perspectives are not jointly exclusive, because they may interact with and influence each other. Additionally, each perspective may have different influence for different individuals because the interconnection for the underrepresentation of women in Physics can be attributed to more than one perspective. The literature emphasises barriers to women's enrolment or success in Physics as a result of inherent differences between women and men, or as a result of traits that one group possesses and the other does not. For example, literature exists that describes critical differences between the nature of girls who are intending to study Physics and those who are not

(Mujtaba and Reiss, 2013), differences between girls' and boys' grade achievement and interest in Physics (Stadler, Duit, & Benke, 2000), and differences in specific characteristics of leaners that predict their Physics enrolment (Thomson, Wurtzburg, and Centifanti, 2015).

Female learners of colour who were a part of this study faced a double oppression that was hard to overlook. In the higher institutions of learning known as HEIs, their male learning counterparts were not exposed to the same double oppression which affected their female counterparts' access to science education. This deduction corroborates the view that race (white learners have more access than coloured learners) and gender (male learners have experienced less barriers to study) play an significant role in determining the level of access within the STEM field (McWhirter's,1997). Furthermore, factors such as the lack of trust in one's abilities, the absence of a sense of belonging and an impetus to study in the STEM fields can obstruct the educational achievements of male and female students as well as prohibit female learners from desiring to pursue the study of STEM courses. This is true without accounting for the role gender plays as a barrier to equal and successful learning. Moreover, it is crucial that research be done to assess, using qualitative methods, the different views about Physical Science that are held by women and men of colour and this study must also investigate the different perspectives women hold regarding Physical Science. This investigation would cast light on the differences between male and female perceptions as much as it would be informative.

In addition, this research will focus on the investigation and analysis of the differences caused by the fact that a person is a woman or a man regarding the apparent hindrances caused by differences in gender and this would help with conceptualizing the consequences of gender profiling. More gender-targeting STEM programmes and education interventions can be developed, and the development of these programmes will be directed by the acquired results so as to ensure that women's challenges are addressed (Ong, Wright, Espinosa and Orfield, 2011).

### 2.2.7 Some research findings

Through survey responses about Physics, Mujtaba and Reiss (2013) investigated the characteristics of 15-year-old girls who had the intention to study Physics after age 16.

In America, Bruning, Schraw, Norby, and Ronning (2004) discovered four cognitive themes that match with integrative Physical Science education as constructive learning, motivation and belief, social and knowledge. Integrated curricular teaching helped learners to improve their performance, and instil an interest and motivation in Science and Maths.

Petroski (2010) claims that Physical Science education is important to nowadays generation as it improves the society's lifestyle. Malaysia usually registers smaller number of learners interested in Science and Technology (S & T) compared to the United States (MOSTI, 2008), and because of this there is shortage of qualified engineers and technicians in that country which was reported as the main obstacle to the Malaysian economic growth (UNESCO, 2010). This could hamper the Malaysian goal of becoming an industrialised country (Saat, 2012). Malaysia has implemented an integrated approach for Physical Science, but no research has been documented to identify the effects of this approach in that country. Malaysia has similar Physical Science challenges as South Africa.

According to Trends in International Mathematics and Science Study (TIMSS), South African schools are among the most underperforming in Mathematics globally. In South Africa, there is tendency for Physical Science subjects to be imposed by parents on learners at secondary schools even if such learners are underperforming in Mathematics (Hernandez et al. 2013).

It is also my concern that some learners underperform at the university's Department of Engineering despite having achieved a good pass rate at high school. The Mathematics department in the South African university conducted a study on cause-effect analysis on teaching calculus to the first year engineering students and discovered that many factors that affect their performance emanated from prior learning of Mathematics at secondary school level (Van der Hoff and Hardin, 2017).

### 2.2.8 Language

**Addressing challenges that are a consequence of language barriers in the classroom**

According to Maree (1994), the medium of instruction used in pedagogical engagements affects the academic performance of a learner. Maree (1994) also maintains good academic achievements can only be attained if a learner is taught in their ‘home’ language. Maree (1994) further argues that it is imperative that an educator does not only use English as the medium of instruction due the fact that South Africa has 11 official languages and different learners speak one more of these languages in their home. Maree (1994) argues that the inability of South African educators to teach in more than one language has left the South Africa’s education system in a precarious situation, more specifically the current state of the pedagogical activities that occur within classrooms.

Maree (1994) also maintains that it is important for teachers to be proficient in English if it is to be regarded as the only medium of instruction because if the teacher is not proficient in English, this will negatively affect the learners’ ability to understand the subject being taught. Consequently, Maree (1994) suggests that teachers whom English is not their first home language must be extensively trained in English as part of their teacher qualification procedure.

Language is one of the barriers in teaching of Physical Science subjects. Although the new Constitution of the Republic of South Africa recognises cultural diversity as a valuable national asset and regards all 11 languages as official, Physical Science in South African schools is still taught in only two languages. The Department of Education recognises this diversity, and in its language policy (1997), it is thus tasked, amongst other things, to promote multilingualism, and respect for all languages used in the country, including South African Sign Language and the languages referred to in the South African Constitution.

Many countries worldwide are multilingual and part of a multicultural society. As a media of communication among the diverse ethnic groups, English is used as medium of instruction at schools in a number of countries, including South Africa, Saudi Arabia, Uganda and Tanzania. Hence both native teachers and learners have to learn English in these countries. The challenges posed by English language to learners whose mother tongue is not English, appear to be common in a number of countries, and all these result in inadequate methods of instructions (Mokiwa & Msila, 2013) and this is the case in township schools of South Africa. Surprisingly, parents usually prefer that their children be taught in English, arguing that it provides better job opportunities since English is an international language. In South Africa, Science, Technology, and Mathematics assessments are presented in either English or Afrikaans (Mokiwa, 2014). As a teacher I have observed that the learners taught in their mother tongue such as English or Afrikaans often have a better understanding of the subject, and therefore perform well in their studies. However, the majority of black learners find themselves at a disadvantage due to the fact that neither English nor Afrikaans is their mother tongue, and this disadvantage negatively affects their academic performance.

According to this document, NCS (2011:14), Physical Science teachers must have an awareness of the part they play in teaching language and as a result they must also prioritize teaching learners (especially those who do not identify with English being their 'home' language) how to write critically by giving them writing activities such as writing scientific texts, reports, paragraphs and shorts essays. Learners must orally present their reports in the classroom so as to make sure that they have better language skills. It further maintains that because language is a necessary tool for communication that plays a powerful role in the definition of cultural identities.

The process of learning Physical Science requires learners to be reminded to learn to be proficient in reading and writing scientific language (O'Brien; 2011:38). Furthermore, the fact that many South African learners do not study Physical Science in English but rather in their second or third language alludes to the existence of a language barrier that prevents South African learners from understanding scientific terminologies. Consequently, the disfluency in scientific language affects learners' essential ability to think, to be experimental as well as their ability to develop arguments using evidence and theories (O’Brien, 2011:38).

Sometimes learners can confuse scientific terminology and concepts with everyday language and as a result, they may misunderstand and underestimate the scientific meaning of some commonly used words such as energy, power etc. Scientific knowledge also boasts extensive kinds of concepts that need learners to use their senses to form connections between unfamiliar sounds and new words such as atoms, cells etc. It is therefore important that teachers develop activities that help learners develop and expand their understanding of scientific terminologies (which they struggle to understand due the unfamiliarity of scientific conceptualization) so that they are able to use their scientific terminologies correctly during lab experiments and when doing class-work. (Setati, 2011:27).

## 2.3 PERCEIVED BARRIERS TO HIGHER EDUCATION IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) IN U.S AMONG HIGH-ACHIEVING

The study of 152 learners of colour who perform exceptionally in their studies exposed them to various stimuli such as stress, coping mechanisms and discrimination in with the aim of:

- Understanding and examining what the learners’ observed to be hindering them from achieving particular learning outcomes in their STEM subjects;
- Analysing whether race and gender have an impact on the varying perspectives of what hinders learning in order to address this double oppression;
- Investigating the relationship between the objectives of the STEM field and the challenges to learning observed by the students; and
- Investigating how these learners overcome the challenges to learning they observed in STEM degrees.

According to Seymour and Hewitt (1997) these learners still felt that they would be exposed to personal obstacles such as lack of confidence in their preparation and intellect despite the fact that they are performing exceptionally well and are interested in Physical Science and Mathematics. These learners also alluded to the fact that pursuing a qualification in the STEM field of study would subject them to interpersonal obstacles caused by differences in race and gender. Other literary sources have highlighted that the existence of marginalization was not masked by the assurance that high intellect guaranteed access to higher education in STEM fields. It alluded to the fact that best performing learners recognized the positionality that marginalization afforded them (Leslie, McClure and Oaxaca, 1998).

These views dispute the notions of inclusivity and equity that a majority of people attribute to the STEM field and highlight the fact that the lack of these positive attitudes makes learners disinterested in studying towards acquiring degrees in the STEM field. Major and O'Brien (2005) are among a group of scholars who have done extensive research that proves that there is inequality and active discrimination against marginalised group in the STEM field which contributes to the loss of career goals for learners of colour who perform exceptionally well and those who perform poorly or have a lack of interest in their studies. They further argue that research can assist teachers and other researchers to develop curricula that will not perpetuate the exclusion of marginalised groups in the STEM field through offering them an understanding of the different obstacles such as emotional instability, discrimination etc., to good academic performance and the pursuit of degrees in this field.

Learners in the STEM field have developed a myriad of solutions that will help to counteract the challenges to their desired STEM goals, and these include seeking support from familiar people and the decision to have more feasible objectives. However, a couple of learners maintained that lowering the standards would be detrimental to their final objectives. These learners were also asked to describe how they would cope in college. They alluded to the fact that they were intellectually capacitated to develop these strategies. These findings will help teachers and research to offer high-school learners training that will ensure that they are able to develop tools that will counteract the challenges they will face in college. In the study, there was a low number of learners with good academic performance who were discouraged from pursuing degrees in the STEM field because of perceptions that there were not capable of succeeding in these field. To understand the ability and coping mechanisms used by learners who persisted despite these negative perceptions, it was essential that further research was done to examine the long-term effects of the observed obstacles.

## 2.4 BARRIERS TO SUCCESSFUL IMPLEMENTATION OF SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION

Literature indicates that there is a lack of learners, staff and professions being produced in the STEM field in the United States and this is despite the release of National Assessment of Progress (NAEP) report which asserted that learners are progressively improving their understanding of Mathematics and Physical Science. However, this study also highlighted that there were no changes in how proficient the learners are in this field. The pedagogy of STEM will help in improving the preparation of the staff for developing the minds that will contribute to the building of the economy.

It is important that teachers adopt a level of creativity when teaching Physical Sciences so as to ensure that the inability to understand scientific concepts and as a result a poor performance in the subject also becomes a crisis for the society. To counteract this unintended consequence, teachers and researchers ought to address the obstacles prohibiting successful learning of the current curricula.

### 2.4.1 Factors that contribute to the loss of interest by learners:

- Poor planning and preparation by teachers
- A shortage in the number of teachers who are proficient in teaching Physical Sciences
- The lack of interest in professional development by teachers
- The lack of collaboration between researchers in all science fields

Freudnthal (1980) and Maree (1999) argue that improving the rate of successful learning requires an equal improvement in pedagogical practices through communication and the sharing of knowledge. Furthermore, schools that have a significantly higher success rate than township schools ought to collaborate with them by offering them access to their facilities as well as engage in staff programmes that will serve as a platform for trading of information. A mentoring programme that will serve as a platform to offer learners advice and motivation can have developed so as to increase learners' interest in the STEM fields.

It is also important for necessary links to be made between the learner's everyday experiences, career goals and the subject matter they are exposed to. Learners must also be provided with career guidance and counselling sessions. Alternative to career being provided by mentors, "teachers must be career counsellors in their own right" (Nzimande, 2010).

### 2.4.2 Poor preparation and shortage of qualified STEM teachers

According to Maree (2011) and Bloch (2009), the basic education of South Africa faces challenges with regards to successful learning implementations than any other level of education. According to Bloch (2009) and Butler (2011), a poor majority, but not always black, of population in South Africa faces a lot of these obstacles to learning and these include;

- Perpetual increment in the poverty levels experienced by mostly people of colour
- A poor understanding of content by teachers due to insufficient training
- Bad management of school infrastructure
- Lack of access to pedagogy materials
- Limited access to career guidance
- Teachers and learners spending less time at school than they are supposed to
- Limited availability of teaching and learning materials;
- Poor channelling of important communique between education departments and the levels of education.

A good quality of teacher training is vital in helping learners reaching higher academic standards. Regrettably, several classrooms today are occupied with underprepared teachers because they have received poor quality training or none at all. Many researchers have piloted research over the past two decades with concern to the association between poor preparation of teachers in Mathematics and Physical Science and learner achievement (Rule and Hallagan, 2006; Hibpshman, 2007). This effort resulted from two events; shortage of literature to identify reliable predictors of learner achievement based on global measures of teacher qualifications (Hill, Bowan and Ball, 2005) and about the components of knowledge necessary for teachers to perform successfully (Shulman, 1986). However, it turns out to be known to researchers that what was known about teacher competencies was insufficient to explain learner achievement (Hibpshman, 2007). This finding has led various organisations such as the National Council of Teachers of Mathematics (NCTM), the National Research Council (NRC), the National Science Teachers' Association, and the Conference Board of the Mathematical Sciences (CBMS) to circulate guidelines explaining the training programmes and endorsement of both elementary teachers and secondary STEM teachers.

The 2007 Academic Competitiveness Council (ACC) report indicated that:

Post-secondary degrees in Maths and Physical Science have steadily decreased in recent decades as a proportion of all STEM degrees. Out of all the undergraduate degrees granted in the US, only 17% are STEM degrees and thus the report also highlights an increase in the number of biology and computer science degrees granted.

One of the major obstacles to successful learning that was observed by 74% of learners who were graduates in the STEM field was poor instruction (Seymour and Hewitt, 1997). The level of knowledge capacity an educator has influences the learning of his subject (Monk, 1994). Ejiwale (2013) argues that slowly increasing the teacher's content knowledge by making them study one course can lead to an increase in the academic performance of their leaners by 1.2 %. However, it is not advisable to add more than five courses to a teacher's mathematical training.

According to Posamentier and Maeroff (2011), Physical Science teachers, the inability of elementary (primary) school teachers to prepare for their lessons causes feelings of anxiety and a lack of confidence that these teachers pass on to learners (Ejiwale, 2013). Acquiring a specialization of a particular subject in teacher training course assists in ensuring that learners perform well in Mathematics and Physical Science (Goldhager and Brewer, 1998). In the research about Physical Science education (Goldhager and Brewer, 1998), the preparation that teachers engaged in remains a mystery as 28% of Grade 7-12 educators in the USA do not have adequate Physical Science education. Similarly, there exists a difference in the level of Mathematical background between teachers from highly impoverished schools and schools with learners from low-income backgrounds (Ingersoll and Perda, 2010).

The turnover rate of teachers in the Mathematics and Physical Science subjects could reach 25000, and 40% of these teachers usually resigned from their jobs in their first year of employment due to limited educators support. The replacement of teachers was a lengthy and time-consuming process, therefore there was a need to ensure that the current specialist and trainee teachers were well trained and that these teachers were trained to work as a collective (President's Council of Advisors on Sciences and Technology report, 2011).

Teacher training programmes must expose future Physical Science teachers to content knowledge so as to ensure that they are knowledgeable and are proficient in teaching their subject matter. This exposure to content knowledge must be accompanied by the relevant social sciences (sociology, philosophy and psychology) that are needed to complement their teacher training. According to Hibpshman (2007), Clark and Ernst (2008) and Deines (2011), the re-standardization of teacher-training must incorporate an exposure to scientific reasoning as opposed to prioritizing the understanding of singular concepts, and this should form part of the process of reviewing teacher-training programmes. The private sector must also be encouraged to partake in the re-standardization of STEM disciplines.

Two important findings from the 2010 PCAST report show that the highest paying jobs have been acquired by graduates who have an extensive knowledge of STEM, and that recent STEM graduates do not readily opt for the teaching profession. The 2011 STEM Report from the Department of Commerce also showed that job opportunities in the STEM fields were becoming increasingly popular in America. This report state that STEM employees earn up to 26% more than their non-STEM counterparts. These findings suggest that there is a need to devise unique strategies for the attraction of

STEM graduates, particularly Physical Science graduates to the teaching profession. The understanding of content knowledge and being equipped with good pedagogical skills are essential tools that a good Physical Sciences teacher ought to possess so that they can help their learners make sense of the subject matter and their everyday experiences. The acquisition of these attributes and professional should be a prerequisite for attaining a teaching qualification.

### 2.4.3 Lack of investment in teachers' professional development

A link between the under-performance of learners and the lack of investment in the professional development of teachers has been identified. This link reaffirms the need for teachers to undertake professional internships for clinical training following the successful completion of their degree. The National Council on Teacher Quality reported that three quarters of pedagogical practices earned a “weak” or “poor” rating (Sawchuk, 2011). What is even more urgent is the need to mentor new teachers and for expert mentor teachers to ensure that the methods that the new teachers use are effective and are to the benefit of all learners. This mentorship creates the opportunity for collaboration between the experienced and new teacher.

Hibpshman (2007) states that the professional development of Mathematics and Physical Science teachers should be an on-going process to help in upskilling these teachers at middle and high school levels. Mervis (2011) asserts that some of the key factors that hinder the learners' chances to success, either direct or indirect, include budget cuts, the lack of investment in teachers and the disregard of poorly performing learners. Herrick (2011) advocates that significant investment into Physical Science education is essential in sustaining enthusiastic and well-equipped teachers. Failure to do this will result in the unfortunate poor teaching methodologies which have an adverse impact on learners (Nwanekezi and Nzokurum, 2010).

### 2.4.4 Poor preparation and inspiration of learners

A recent study by Microsoft and Harris Interactive (2011) indicates that most learners who decide to further their education in STEM fields into tertiary education decided to do so in high school or sooner. However, only 20% of these learners felt that when they were prepared for the transition from high school to tertiary in these fields. The research also found that males and females entered into these fields for different reasons, females being more propelled by their need to 'make a difference' while men enjoyed the challenges associated with these subjects. A 2010 PCAST report concluded that an alarmingly few learners are capable in STEM and that even fewer of those learners who are proficient go on to pursue STEM fields. More than 70 percent of eighth graders who underperform in Physical science subject face an uphill battle as they experience increased difficulties due to the lack of solid foundation in their formative school years.

Learners must have a strong foundation in STEM regardless of the chosen career path. This preparation should also involve the easy access to information and the sharing of knowledge and skills. On the other hand, learners should be inspired to pursue careers in the STEM fields. According to Laboy-Rush (2011), when teachers expose learners early to opportunities to learn Maths and Physical Science in interactive environments and ways that are enjoyable for the learners, it grows their confidence and develops their communication skills to become competent STEM learners.

### 2.4.5 Poor educator and learner interpersonal connections

According to the 2008 CRS Report for Congress titled, "*Science, Technology, Engineering, Technology and Mathematics (STEM) Education: Background, Federal Policy, and Legislative Actions",* the achievements of American learners appears inconsistent with its role as a world leader in scientific innovation in comparison to other countries. Learners should be introduced to different ways of connecting with each other to help with their learning in STEM programmes (Darling-Harmond, 1994). Latest research made into the impact that group-focused learning has on learners shows that projects and assignments can enhance the learner's interest in STEM because they are focused on collaborative group work effort to bring forth solutions (Fortus, Krajcikb, Dershimerb, Marx, & Mamlok-Naamand, 2005). In additional, learners are fully immersed in the process of reflecting on the problem-solving process (Aleman, 1992; Darling-Hammond, 1994; Fajemidagba et al., 2010). Learners learn best when stimulated to solve problems of the world around them (Satchwell and Loepp, 2002).

### 2.4.6 Poor school support structures in place

The study published by the Education Alliance at Brown University stated that school systems will be most efficient and effective when structures that hinder the growth of and support to leaners are altered (Unger, Lane, Cutler, Lee, Whitney, Anrude and Sylvia, 2008). It is imperative for teachers to be knowledgeable about Physical Science education to help in facilitation of an enriched learning process for leaners. Unfortunately, the lack of funds available to schools hinders teachers from providing the necessary educational and emotional support to their learners. A remedy to this would be the hiring of qualified volunteers who are STEM practitioners so that learners are not at a disadvantage. On the other hand, according to the 2011 National Survey on STEM Education conducted over 400 STEM leaders responded that "*The most frequently identified funding sources were grants from private foundations (31.9%) and district-led initiatives (25.9%).*" As such, leaders who lack funding could develop STEM alliances that rely on both public and private funding.

### 2.4.7 Lack of research collaborations

Numerous Physical Science teachers have been unsuccessful in their determination to collaborate with other Physical Science teachers. The lack of representation within the STEM fields discourages leaners to pursue STEM related careers. Research collaborations through cluster concepts across STEM fields for integrated curriculum will enhance access to information and resources among the stakeholders. As such, all efforts should be placed in the facilitation of collaborative research work. These collective collaborations will aid in the changes to approach and curricula of the STEM programmes.

### 2.4.8 Poor content preparation

In the increasingly competitive global economy, there must be a proportional number of learners who acquire an education to the STEM fields. When preparing instructional materials, it is advised that a sketchy outline of the process and content should be transformed into feasible learner guides and instructional resources, including tests, and teacher instructions (Rothwell and Kazanana, 1992. New learners will be attracted into STEM fields if the curricula are reconstructed to suit issues faced by modern society. Additionally, the specification of targeted outcomes aids teachers in conducting focused learning and identifying areas in which learners struggle the least and most.

### 2.4.9 Inappropriate methods of assessment

Brunner (1961) suggested that the mental and physical stimuli aid learners better in their understanding of the work. According to Onuja (1987), the teaching techniques used are directly correlated to the amount of work the learner is able to grasp and understand. Physical Science teachers should not only be knowledgeable in the subject, but also possess the basic and necessary skills with which to impart the knowledge of the subject to the learners and learners at all levels of learning (Nwanekezi et al., 2010). Ineffective teaching methodology reflects in the learners' future choice of career. This necessitates the teacher's knowledge of different styles of teaching methods and the understanding of what would work best in their classroom, given the diversity of the learners (Ejiwale, 2013).

Diverse approaches to teaching methods, content instruction, and curriculum organisation come and go over the years (Guild, 1998). Experienced teachers know that the most effective way of teaching STEM courses is to adopt a variety of teaching methods. In this way all learners will have an opportunity for success. It is also important to note that learners who are engaged in Physical Science education should be made aware that Physical Science is only one of the many subject Pin the STEM fields and so the analysis and application of the work remains uniform even within other Physical Science disciplines. As such, the method of assessing learning outcomes should not only be based on cognitive domain, but it should also include affective and psychomotor domains. This will help develop learners' basic skills and enhance the interest in STEM subjects (Nwanekezi et al., 2010).

### 2.4.10 Poor condition of classroom facilities and instructional media

According to the article published in Education Week regarding classroom management by Krueger and Whitmore (2001), the result of the five years' research done by University of Wisconsin asserted that learners spend most of their time in classrooms and thus overcrowding in classrooms could be detrimental to the learning process of learners. The study affirms that smaller class sizes can result in higher achievement for children living in poverty. Therefore, the environment of the classroom and laboratory should be made conducive to learning.

STEM education is meant to help in preparing many future Physical Science practitioners. Inadequate facilities and the lack of trained and committed teachers will continue to weaken STEM education implementation at all learning levels. Unfortunately, most school facilities used were built in the second World War and almost all of them were not equipped to facilitate STEM education (National School Boards Association, 1996). When teaching materials are insufficient, teachers should learn to improvise (Nwanekezi et al., 2010). Necessary changes implemented in schools will enhance educators' ability to create a conducive learning environment for learners (Ejiwale, 2012).

### 2.4.11 Hands-on skill practice for learners

Another realistic approach to implement STEM education effectively is to offer hands-on training for the youth training to be engineers in the future. 'Shadowing' professional engineers will help learners familiarise themselves with the day-to-day tasks faced by qualified engineers. This is all while benefitting from the powerful advantage of internship and cooperative education. This reformation will make learning learner-centred, sustenance of the role of STEM educators “from providing information to providing structure, support, and connections to the resources” (Glasgow, 1997, p. 123) and this will be the way to go. Cooperative learning is also a great choice of teaching method because it promotes collaborative work and the sharing of responsibilities of tasks. Integrated curriculum is successful because it offers opportunities for connections that are organically cultivated in some learners' minds and for the chance to study a topic in-depth. Indeed, educational innovations that have worked can trace a relationship to some learners' preferred learning patterns (Ejiwale, 2013).

The challenges at the primary and senior primary level must be fixed in an attempt to fix barriers to Physical Science education at high school level. Teacher-training is essential for the successful implementation of Physical Science education. More focus should be directed to ensuring that in-service and former teachers collaborate to improve the quality of Physical Science education in high schools. It is important that teachers are better equipped to exercise necessary classroom management. This can be done through the provision of courses on the relevant pedagogical styles.

Mevis (2011) maintains that the success of a Physical Science school learner depends on the availability resources and adequately trained teachers who actively built a conducive learning environment. Successful facilitation of learner activities relies on adequate preparation and successful counteracting of challenges that may be experienced during laboratory experiments and classroom lessons. The reconceptualization of the duty of teachers in the STEM subjects must be reflected through learner participation in classroom activities which are hands-on and require a connection with other experiences. A complimentary shift in the medium and type of instruction should help in planning the delivery of the lessons.

## 2.5 THEORETICAL FRAMEWORK

Ayodele, Ojewole, Olutunde and Oluwatoyin (2014:193-205) used the theoretical tools of analysis of Professor Albert Bandura to study how learning occurs. According to Groenendijk, Janssen, Rijlaarsdam & Van der Bergh (2011:1-16), observations of learning the interpretation and evaluation of their peers performing learning activities forms the basis of learning, and this is known as the Observational Theory. There is a connection between observational and social theory. After the adoption of this presupposed connection, social and behavioural theorists maintain the notion that good or bad behaviour cannot be learnt (Ayodele et al., 2014:193-205).

Through the promotion of performance and motivation of the learner, observational learning theory seeks to enhance the creativity and independence of thought amongst learners. The examination of the behaviours and responses of learners during learning that were conducted in this study were influenced by observational learning theory (Groenendijk et al., 2011:1-16).

The ability to do a thorough analysis of the thinking capacity of the respondents in this study depended on a critical questioning because the intellectual ability of the respondents was associated with their academic performance (Thompson, 2014). The analytical framework of this study was deduced with reference to critical thinking theory which is a theory that shapes characterization and the relegation of properties. According to Thompson (2014), learners need support to acquire vital scientific skills such as “problem-solving, conducting scientific experiments acquiring active learning skills and achieving self-discipline”. These skills are essential for critical thinking.

According to Mafukata (2016:68-79), behaviourism informs some of the prevalent teaching practices used in Physical Science education in South Africa. This theoretical framework is used by teachers to achieve the prescribed pedagogical objectives. The poor transition from the Bantu education system has led to inadequate teacher-training and support.

This study concludes that in order to perform a thorough analysis of their problems and to draw conclusions from their findings, learners would have to embrace a variety of theories. According to Mafukata (2016:68-79), the investigation of the barriers to good learner performance in Physical Science in Vhembe District Schools relies on the adoption of the whole system analytical framework (which is an extension of the input-process-outcome framework) for a study which was used by scholars such as

Muzah and Howie. According to Kriek and Grayson (2009) and Mafukata (2016:68-79), the nature of the problem being investigated influences which range of the theoretical frameworks is used in a study.

## 2.6 CONCLUSION

This chapter focused on aspects pertaining to the teaching of Physical Science in the classroom and also included the theoretical lens which focuses attention on the role of influential factors such as poverty and the classroom environment. Further, the emphasis was on how learners observe what was occurring in the classroom to further their knowledge in the classroom. In the next chapter the researcher discusses the research design, the methodology and the data-collection, including the methods used for the collation and analysis of the data. The next chapter also describes the sample and explains how the sample was chosen.

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 INTRODUCTION

The study followed the qualitative approach used a case study design. According to Creswell (2017) qualitative research is an inquiry process of understanding where the researcher develops a complex, holistic picture, analyses words, and reports detailed views of informants and conducts the study in natural settings. A qualitative approach has assisted the researcher to find out why the learners' performance in Physical Science was not of a high quality and what were the barriers that impeded their performance. The study used the qualitative approach, since the interpretive researcher depends on participants' views to collect data. The interpretive researchers do not usually start with the theory, but they inductively develop a theory of 'pattern of meanings' throughout the research process (Creswell, 2017). The purposive sampling was used, since it allows the researcher to select the relevant participants to be involved in the study and to collect reliable data while saving the researcher's time.

## 3.2 RESEARCH DESIGN

An intrinsic case study design was used to identify the barriers that contributed to poor quality of results in Physical Science at secondary township schools in Gauteng Province. In a case study, the researcher's perceptions and interpretation become part of the research and as a result, a subjective and interpretative orientation flows through enquiry (Creswell, 2017). Interpretive refers to approaches in the social sciences that are interested in the meaning of human actions. The Interpretive approach is also about the understanding of the world of human experience and reality in a socially constructed world (Cohen, Manio & Morrison, 2011). The researcher designed the study in such a way that the information gathered from the participants was recorded on the observation schedule and recoded on the voice recorder during the face-to- face dialogue semi-structured interviews processes which helped to gain data for the objective of the study which were to explore how learners learn Physical Science in high performing township secondary schools and to identify learner's barriers of learning Physical Science in township secondary school.

### 3.3 POPULATION AND SAMPLING

Data was collected from a sample of 15 learners and four teachers from three township secondary schools doing Physical Science. The 15 learners who met my selection criteria willingly participated in the study. Population is the largest group of potential participants of a qualitative study, which Banerjee and Chaudhury (2010) define as an entire group about which some information is required to be ascertained. Tshwane West district consisted of 55 secondary schools of which were too many for the researcher to use in the study hence we selected three township schools in order to represent all the secondary schools taught Physical Science with barriers of high performance. Participants in the general population must share at least a single attribute of interest (Bartlett et al., 2001; Creswell, 2003).

Sampling is defined as “the selection of research site, time, people or event in the research field” (Merriam, 2002). According to Dawson (2002) “the number of the participants in the sample depends on the questions being asked, data being gathered, the analysis and also the resources to support the study”. The study consisted of four teachers and 15 learners that assisted to find solution of the research question in the study. The purposeful sampling was relevant to the study as it is described as the “sampling method that involves selecting objects with the required characteristics being those that the researcher can get the most relevant information from” (Dawson, 2002:49; McMillan and Schumacher, 2010:326).

Three township schools were sampled from Tshwane West District to participate in qualitative research to make it easier for the researcher to analyse the data and also to reduce the costs of travelling. The three participating schools were selected based on the statistics of township schools’ results offering Physical Science in Tshwane West District obtained from the district office. The purposive sampling was used to select three schools with barriers of high performance in Physical Science among learners in township secondary schools. Two teachers teaching Physical Science in Grade 11 and 12 per school participated from the three identified schools. Depending on the teacher’s workload (time table), they were 15 Physical Science learners (Grade 11 and12) from schools that participated in the study. The four teachers who participated in the study were experts in Physical Science, and shared their experiences with the researcher on barriers of high performance in Physical Science from township secondary schools.

The case study was conducted from three township schools (see Appendix C), of which one from Soshanguve, one from Winterveld and the last one from Ga-Rankuwa township in Gauteng Province from Tshwane West District. The purposive sampling was appropriate for qualitative research. The purposive sampling helped me as the researcher to interact with the participants that contributed to the study. The sample represented the secondary township schools was relevant to my study (schools with barriers of high performance in Physical Science) and has provided answers to my research questions.

## 3.4 DATA COLLECTION

Data for the study was collected in two phases. Phase one was for lesson observations (the researcher was a non-participating observer), which sought to elicit the causes of barriers to high performance in Physical Science. The study focused more on how learners learn Physical Science in high performing township secondary schools. During lesson observation (Appendix E was used), notes were recorded of the classroom environment, lesson presentation and learners' behaviour. The lesson observations were done in the classrooms during school hours. The lesson observed was for Physical Science Grade 11 and 12 taught by different teachers for not more than 40 minutes per lesson in each selected township secondary school. Therefore, the three selected secondary township schools were observed the same way. The researcher observed the Physical Science lesson presented in class and listened to what was being taught in class and how the learners responded to the questions asked by the teacher. The researcher explored the learners' workbooks to determine how they did their classwork. The researcher also observed how they attempted to complete the classwork as individuals.

Phase two focused on the interviews of two teachers and five learners per township secondary school. The interview focused on identifying the barriers of high learner performance in learning Physical Science in township schools from teacher's and learner's point of view and also according to their experience for about 15 minutes per participant. Face-to-face semi- structured interviews took place with willing teachers

(Appendix F was used) and learners (Appendix G was used) for about 15 minutes per participant after teaching hours so that it did not interfere with school programme. The interviews were also digitally recorded with the permission from the participants.

**Table 3.1: Overview of data collection method**

| Phase | Instruments | Nature of the empirical material | Research Question 1 | Research Question 2 |
|---|---|---|---|---|
| 1 | Lesson Observation | Researchers' observation using observation schedule | ✓ | |
| 2 | Semi-structured interview | Audio-recorder and transcriptions | | ✓ |

Multiple methods of data collection are usually used in case study research to strengthen triangulation. The interviews of teachers and learners, also lesson observation were used to gather the data. According to Morse (2003), multiple methods are used in the planned study and conducted to answer a particular sub-question.

## 3.5 ISSUES OF RELIABILITY AND VALIDITY

The Physical science lessons were observed at more or less the same time of the day at all three selected schools, and lesson observation schedule was used the same way to ensure reliability in phase one of data collection.

Reliability was ensured during the interviews of leaners and teachers (phase two of data collection) by making sure that the questions asked to:

- the learners were the same, in terms of the order in which the questions were asked, and the language used was understandable to all the learners;
- the teachers were the same but different from the ones given to learners;
- both the teachers and learners were audio-recorded consistently and transcribed accurately;

Validity was used to check if the lessons observed (in phase one) and interviews conducted (in phase two) answered the research questions of the study. Holton and Burnett (1997) believe that instruments used to measure reliability and validity are valid if they measure what they are supposed to measure. Therefore 15 learner participants identified the common measures of barriers of high performance in Physical science from their township secondary schools. Hence, the interviews conducted and lessons observed in this study were regarded as valid and accurate.

Qualitative data are about trustworthiness and crystallisation. Credibility ensured that the findings were real and established trustworthiness. I made sure that the participants were comfortable with me and trusted me in order to produce valid data. Triangulation was used to reduce the effect of bias. The digital recorder revealed the feelings and the attitude of both the participant and the interviewer.

The table below shows the bibliography of the participants (learners and teachers) in the study. The participants were given code names to protect them and to make it easy to transcribe the data.

**Table 3.2: Bibliography of the participants (learners and teachers) in the study**

| Participants | Code names | Age | Gender | Race | Grade |
|---|---|---|---|---|---|
| Learner 1 | L1f | 17 | Female | African | 12 |
| Learner 2 | L2f | 18 | Female | African | 12 |
| Learner 3 | L3m | 18 | Male | African | 12 |
| Learner 4 | L4m | 18 | Male | African | 12 |
| Learner 5 | L5f | 17 | Male | African | 12 |
| Learner 6 | L6m | 17 | Male | African | 12 |
| Learner 7 | L7f | 18 | Female | African | 12 |
| Learner 8 | L8m | 18 | Male | African | 12 |
| Learner 9 | L9f | 18 | Female | African | 12 |
| Learner 10 | L10m | 18 | Male | African | 12 |
| Learner 11 | L11f | 18 | Female | African | 11 |
| Learner 12 | L12m | 17 | Male | African | 11 |

| | | | | | |
|---|---|---|---|---|---|
| Learner 13 | L13f | 17 | Female | African | 11 |
| Learner 14 | L14f | 17 | Female | African | 11 |
| Learner 15 | L15m | 17 | Male | African | 11 |
| Teacher 1 | T1m | 32 | Male | African | 11 and 12 |
| Teacher 2 | T2m | 42 | Male | African | 10 and 12 |
| Teacher 3 | T3m | 46 | Male | African | 11 and 12 |
| Teacher 4 | T4m | 38 | Male | African | 11 and 12 |

## 3.6 DATA ANALYSIS

The data were analysed in two phases. Phase one involved the analysis of lesson observation of which the researcher attended the four Physical Sciences lessons from three township secondary schools.

By the end of the lesson, learners were asked to reflect (the teacher asked learners to tell the class what they had learnt) on the lesson taught in class.. Hence, they answered research questions about how learners learn Physical Science in high performing township secondary schools.

The data were grouped into themes and analysed. The themes were derived from the research questions. The findings assisted in understanding of how learners learn Physical Science in high performing township secondary schools.

Phase two involved analysis of the interview of the Physical Science teachers and learners. The data were categorised according to themes which were formulated from interview questions for learner and teachers then interpreted (Terre Blanche & Kelly, 2002). According to Creswell (2014:196-200) the qualitative approach, incorporates six data analysis steps to be followed. These include organisation and preparation of the data for analysis (that is where the interviews are transcribed, organised and sorted), reading through all the data in order to find the general idea, coding data, categorisation the data into themes, presenting the results (narrative) and interpreting results in order to answer the research questions on barriers to high performance in Physical Science in township secondary schools.

## 3.7 ETHICAL CONSIDERATION

According to the Helsinki Declaration of 1972, it is imperative to obtain clearance from the ethics committee when human (or animal) subjects are involved in any kind of research of an empirical nature. Hence the UNISA College of Education Ethics Review Committee granted me the permission to collect data since my research ethics had been approved. Permission to conduct the research (see Appendix B) from three secondary townships was obtained from the Gauteng Department of Education (GDE). Tshwane West District Director allowed the researcher to collect data from the three secondary schools (permission letter is attached as Appendix C). The School Principals and the Schools' Governing Body (SGB) allowed the researcher to collect data from their schools.

Parents of the participating learners signed the consent form willingly, in the event that they consent to participate in the study. It was also explained that, should participants want to withdraw from participating in the study at any time during the research process, room would be made to that effect. During the study the researcher was honest, respectful, sensitive and protective to the participants. The participant's responses shared during survey will be kept confidentially and privately. Burns (2000) posits that both the researcher and the participants must have a clear understanding regarding the confidentiality of the results and findings of the study. The research was conducted according to the Ethics and Research Statement provided by the University of South Africa.

## 3.8 LIMITATIONS AND DELIMINATIONS OF THE STUDY

Limitations are constraints to the study based on research methodology and design. Limitations are constraints that the researcher cannot control in the study (Miles, 2017). Delimitations are defined as self-imposed restriction to the scope of the researchers' study (Miles & Scott, 2017).

**LIMITATIONS**

- The study was limited to three schools in the Tshwane West District of Gauteng. Given the big number of township schools in the country, this was a small representative of township schools in South Africa, and therefore there is a possibility that the views expressed by the participants in this schools may not fully represent the views of other Township schools in the country. However, to ensure that the views from the three sampled schools were a true reflection of township schools, the three schools were located at different townships within the Tshwane West District.

- The study was confined to grade 11 and 12 learners and teachers, and yet it is common knowledge that barriers of high performance manifest themselves to all school levels. However, the interview questions did not confine learners to only barriers that only manifest themselves at Grades 11 and 12. Learners were allowed to mention barriers that impede performance at previous grades.
- Due to financial and time constraints, only 15 learners and four teachers took part in the study. The number of participants is not convincing enough of the findings in the study but it was not under the control of the researcher. Despite the total small number of learners and teachers interviewed, most of the participants raised the similar issues, and were in agreement with the manner in which the issues impede high performance.

**DELIMITATION**

- The study focuses on the barriers to high performance in Physical Science of the selected township secondary schools in South Africa.
- The selected township secondary schools were schools that obtained the pass rate of 90% to 100% in Physical Science in the year 2017.
- The researcher selected Tshwane West District township secondary schools since South Africa consists of many districts.
- Due to time restriction, three schools were selected from Tshwane West District in Gauteng province to conduct research hence the qualitative approach was used to generalize the findings of the study.
- The participants in the study were the Physical Science learners and teachers from the selected township schools only (the names of the selected township schools are on Appendix C).

- The teachers were all qualified to teach Physical Science and also had the subject experience.

## 3.9 CONCLUSION

This chapter explained the process that was used to collect information from learners and teachers and why it was chosen; sampling methods used in the study were also discussed in detail. The chapter further described the data collection instruments and the rationale behind their selection. The scientist also defined the methodology she followed to gather and analyse data. The chapter also clarified how validity and reliability were ensured and also explained how the ethical considerations were obeyed during the collection of the data. In the next chapter the researcher presents and interprets the results, and draws conclusions of the study.

# CHAPTER 4

# PRESENTATION OF FINDINGS

## 4.1 INTRODUCTION

Chapter 3 defined the research design and research methodology procedures of the study while this chapter presents and interprets the results and the findings of the study. The results of the study were presented according to identified themes. The results of the study were categorised according to the research questions of the study. A qualitative method approach was used during this investigation and the instruments used to collect data are attached as Appendix E, F and G. The data gathered from lesson observations of Physical Science, face-to-face interviews with Physical Science teachers and Physical Science learners at the three selected secondary township schools in South Africa was be used to identify the barriers to high performance in Physical science and how the barriers could be eliminated.

## 4.2 LEARNING PHYSICAL SCIENCE

The findings emanating from the interviews held between me (as the investigator) and the teachers and learners regarding the learning of Physical science are presented here. All questions asked to Physical Science learners and teachers from three schools are presented in Appendices F and G, respectively.

### 4.2.1 Qualitative interview responses

#### 4.2.1.1 Theme 1: Enjoyment of Physical Science

On the question of whether learners enjoyed learning Physical Science, the overwhelming response from a total of 15 learners from three schools (5 per school) who were interviewed was that they indeed enjoyed learning the subject. Of the 15 learners, the majority said they enjoyed learning the subject yet three said they did not. Thasmai (2013:18) argues that a learner’s academic performance is also dependent on whether the teacher can keep the learner interested in their subject matter, this coupled with pedagogical skills and subject matter understand is essential in ensuring successful learning.

One of the reasons for not enjoying the subject was that it is very difficult, and that they were compelled to do Physical Science if they had to do Life sciences.

Lastly, they said home chores were too many, so it was difficult for them to do homework and study at home.

Learner participant L1f said:

> *I do enjoy the subject, but I prefer the Life Sciences and the information on the human anatomy and vegetation. The chemical section of Science is problematic and requires much concentration and focus. Since I have to do so many chores around the house, I cannot spend so much time on my Physical Science homework.*

Learner Participant L4m said:

> *It is hard to study at home as I do not have a room for myself and I share with my other siblings. They go to bed early and I cannot study so late then. It is really difficult since space is a problem.*

Concerning the part that they enjoyed learner said that they enjoyed learning new things, especially the experiments where they get to see the reaction of the chemical substances. They however said the school did not have all the needed resources and the teachers sometimes just have to orally explain the experiments which makes it very challenging. They however enjoyed the group work and socialising with other learners.

Learner participant Lf5 said:

> *I do enjoy the subject and the group work as I learn from my friends. They can sometimes explain aspects to me which I do not understood if I only listen in class or hear it once. It helps if it is slowly repeated so that I can grasp the essentials. I do not always have confidence to ask questions in class. I am too scared.*

A similar question was asked to the Physical science teachers from the three schools to find out if they do enjoy teaching Physical Science. Again the overwhelming response from four teachers was that they do enjoy teaching the subject.

Teacher participant 3 (Tm3) said:

> *I really enjoy teaching my subject yet there are many challenges. The part that I enjoy the most is to share my knowledge and to see how some learners understand better after I have explained. Other challenges are that we do not always have all the needed equipment and resources. Nonetheless, we do what we can with what we have and try to be creative.*

Participant Tm4 said:

> *We sometimes take our learners on excursions and that I enjoy the most since it helps to expose the learners to real-life situations. It is also a privilege to see how learners appreciate what we teach them. The large number of learners is however difficult to deal with.*

Participant Tm2 said:

> *I enjoy caring for my learners and to teach them life skills. It is not only about the Science work but caring about the learners holistically.*

#### 4.2.1.2 Theme 2: Learner motivation to take Physical Science

The four teachers from the three schools agreed and said that learners are always encouraged to link subject matter with real-life situations; they always connect with the scientific world and bring their knowledge to the classroom situations focused on to understand the Physical Science lessons. Teachers also mentioned that learners must know how Physical Science connects with nature and what the impact of Physical Science in society is. They endeavour to create an environment conducive to understanding Physical Science. Some teachers (two of the four) said that learners are assessed more frequently, and often have one-on-one sessions with teachers who ensures that those who perform poorly receive extra attention and are motivated. Teachers also reported that they motivate learners by making sure that they are prepared for the lesson and the lesson presentation starts on time. In addition, they said that they make sure that they know their learners' background and trust them. Teachers and learners did not mention any rewards used to motivate learners.

Participant L5f said:

> *We are regularly assessed and we write tests. There are a prescribed number of tasks that we need to complete. Time is sometimes not enough as it takes time to follow and understand concepts. Physical Science has mathematical calculations as well and these need to be explained in detail. If we rush we do not follow.*

Participant L6m said:

> *We would really be motivated if we could receive incentives and if we are rewarded in a way with prizes to encourage us to try harder. Maybe we need to know about the bursaries we can get if we are successful in our studies and we also need to know how excellent marks can influence our future and career possibilities.*

Intrinsic and extrinsic motivation both influence the learners. The teachers said that parents have an important role to play when it comes to extrinsic motivation, since they need to encourage their children. However, due to the difficult conditions at home, children have to assist their parents in doing household duties and extra tasks to be done at home.

T1m said:

> *It is difficult to motivate learners to study Physical Science if the parents do not support us. Some parents are very poor and they need all the help they can get to make ends meet at home. This problem with financial challenges impact the learners' academic Physical Science performance negatively.*

T2m opined:

*It is true that learners differ in their aptitude and attitude. If their attitude is positive, they are able to overcome any academic challenges. It is however sad if the learners' aptitude is not positive as that means the teachers have to work harder to motivate the learners to achieve high marks in Physical Science. It is also true that gender influence is observed as girls are seen to be raised to cook and do household duties rather than being encouraged to become engineers and scientists.*

#### 4.2.1.3 Theme 3: Suggestions to improve Science marks

Teachers suggested that the Grade 11 to 12 Physical Science content should be reduced by diverting part of it to Grade 10 in order to alleviate the congestion of the syllabus in Grade 11 and 12. For example Newton's Laws 1, 2 and 3 could be taught in grade 10 instead of Grade 11.

The policy for the progressed learners whose subject combination include Physical Science needs to be reviewed. The training and recruitment of more Physical Science teachers must be done. Acknowledgement of Physical Science teachers and support from the district could also motivate teachers.

Teachers should be supported on content by organising Physical Science workshops. The Grade 10 Physical Science learners need to write common selection tests, and use these tests as a criterion to qualify to do Physical Science in Grade 11. Teachers should be appointed for marking this test and give feedback to other teachers. Lastly, the district must make sure that schools have enough resources to learn and teach Physical Science.

T3m posited that:

*The tests that can be written to ensure that the most appropriate learners take Physical Science is really a way to see if learners will cope when they take Physical Science in the more senior grades. It is imperative that learners who have no interest should not take the subject, since their negative attitudes will cause them to achieve poorly. Some learners lose all confidence because they are compelled* *to take the subject in order to study certain courses at university, but they have no interest in the subject. A love for Physical Science is really important.*

The teachers felt that teaching must have meaningful teaching content without being too concerned about the Annual Teaching Plan (ATP); they must sometimes spend more time to assist learners in understanding Physical Science concepts. They sometimes need to put in much effort to help struggling learners by adding external teaching time. Teachers reported that they had to be accountable to the learners to make sure that all work is covered in accordance with the CAPS document. To be able to cope with the workload and all the additional challenges, it is recommended that the department should reduce the subject content in Grades 11 and 12. In this regard T2m said:

*We are aware that learners need to cover the broad spectrum of the syllabus, but it is really impossible to do all the work in the Grade 12 year. The department should consider to prescribe a large chunk of the Matric work for Grade 11. In that way all the needed work is covered but the workload is more manageable in Grade 12.*

T4m said:

*Grade 12 is such a crucial year, and that learners must have a positive attitude to succeed. It is really hard if a learner just does not take it without any valid reason and we, as teachers, must try to help them realise their dreams. I also think we need extra time on the timetable to be able to cover all the work. Languages (e.g. English) receive so much time, and yet English is also used in the Physical Science class.*

#### 4.2.1.4 Theme 4: Teacher and learner relationships

To my surprise, 10 of the 15 learners responded very positively by saying that they had a good teacher-learner relationship. However, only three learners said they did not have a good relationship with their teachers. The majority of the learners said they had a very good relationship with their teachers in such a way that they were free to ask questions and the teachers would answer them professionally and that they understand the work. Learners also reported that they accept their teachers as their parents. By teaching learners on Saturdays, the teachers were showing them that they were special. This gesture by the teachers inspires and motivates the learners to understand Physical Science. Among the few learners who described the learner-teacher relationship as strained said they were afraid of their teachers. Some said the teacher was still new to the school, so they are still trying to adapt to him.

L9m said:

> *When there is a new teacher, it takes time to build a relationship. It is very difficult to adjust to a new teacher in your Grade 12 year. We really battle to understand what the teacher is trying to communicate. Trust is earned.*

*L10f opined:*

> *Yes, I do not really feel that the new teacher understands us. It will take time to build a relationship. We do not know if he knows the subject that well. It makes us feel insecure.*

It was clear from the learner responses that learning Physical Science in Grade 12 is very challenging and that it helps if the learners know the teacher well. Relationships are a definite influential factors when it comes to the barriers to academic performance in Physical Science.

#### 4.2.1.5 Theme 5: Parental support

The response from learners was really amazing as the overwhelming majority of learners said they were receiving adequate support from their parents, particularly with regard to homework, provision of tutors for extra lessons, purchasing of study materials, monitoring of their performance in Physical Science and other subjects, always encouraging them to work hard, and provision of financial support for transport to attend extra Physical science lessons on Saturday or Sunday. A study by Chinyoka and Naidu (2014:223) shows that the inability of impoverished parents to offer their children assistance with schoolwork is a consequence of their failure to obtain education.

L12m said:

> *My parents do support me to attend the extra lessons on Saturdays, but I know my friend has to work and help her parents by selling vegetables as they need the extra income to cope financially. But I am grateful to my parents that they support me to*

*learn more on Saturdays. Saturday classes are enjoyable as we are not pressed for time and we can then take our time to understand certain mathematical calculations.*

This is in contradiction with what the teachers said about the parental support. Learners tend to speak more openly with their teachers when their marks are poor. It was commendable that learners spoke so positively about their parents, yet teachers said parents let their children run many errands for them and that prevent learners from doing their work effectively.

T4m said:

*Yes, it is true that parents do give their children extra money to attend on Saturdays, but there are many learners who do not have the funds and those are the ones who really need the extra lessons.*

#### 4.2.1.6 Theme 6: Academic goals in regard to Physical Science marks

The interview data revealed that specific academic goals featured as a prominent theme. The learners responded that they were realistic in that they knew what their current marks were and they were aware that not all of them were distinction candidates. Teachers responded with enthusiasm that they wanted a 100% pass rate with more distinctions (level 7), and at least all of them (learners) obtaining 50% (level 4 +). Teachers also said they would like to see an increase in the number of learners obtaining a Bachelor's degree so that they can qualify for further studies in any of the careers which involve Physical Science at tertiary level.

L9f said:

*Our Grade 10 marks were very poor. In Grade 11 we did better and this year my marks were much higher. I think we gradually start to understand the work.*

L8m said:

*I am not achieving very good marks for a number of reasons, but I am positive as I know that if I want to become a Scientist one day I need to be able to understand* *the school work. I heard the Physical Science at university level is very advanced but that the resources are much better and the labs are fully equipped.*

T2m said:

*Learners do very poorly in Grade 10 as a rule and then they start to improve. That is a phenomenon we observe.*

T3m said:

*We are aware that everything in life should not be achievement-driven but unfortunately a school's pass rate is a reflection of the school's success and prestige. It is really important that most learners achieve at least 50% and if we can have a few distinctions of course we are very grateful and excited.*

**4.2.1.7 Theme 7: Teacher qualifications and teaching experience**

The majority of the teachers were quite inexperienced. Only one had 10 and more years of teaching Physical Science experience in township schools with an excellent pass rate, ranging from 80 to100%. It was evident that experienced teachers had more success in teaching Physical Science as a subject than less experienced ones.

The teacher's qualifications in Physical Science were as follows:

Teacher 1: B.Ed. Hons.

Teacher 2: B.Ed.

Teacher 3: B.Ed.

Teacher 4: B.Ed.

One of the four teachers had BEd Hons and the rest had a BEd in Science Education. As an indication that the teachers were adequately competent to teach the subject, two had been appointed as markers, one as senior marker, and the last one as Deputy marker of Grade 12 Physical Science final examinations. Generally, all the teachers from the three schools were suitably qualified and experienced to teach Physical Science.

Although the grade 12 teachers were adequately qualified, it was not clear why the performance was still so poor. Teachers also spoke about the influence of the teachers who taught these learners in grades 8 and 9, and said some teachers in these grades were not qualified to teach Physical Science. They said the foundation is very important and that they could only salvage what they could do in the short period that they had the learners in their care. Poorly qualified teachers at lower grades could therefore be another teaching and learning barrier, since it does not help if only the Grade 11-12 teachers were properly qualified.

#### 4.2.1.8 Theme: Barriers in Physical Science

Teachers were asked to mention the challenges they encountered while teaching Physical Science. Interestingly, all four teachers had experienced common challenges, and a summary of these include the following:

- Failure of learners to do their homework;
- Learners who are always absent or late for the Science lesson or school;
- Failure of learners to attend extra classes;
- Due to financial difficulties, some learners do not have sufficient learning material such as pens, calculators and workbooks;
- The underperformance of Grade 10 and 11 learners, subsequently lead to a poor pass rate in Grade 12;
- The shortage of apparatus and chemicals in the laboratories was regarded as the major challenge in township schools;
- Learners are forced by parents to do Physical Science by simply choosing the subject for them;
- Learners are poorly motivated;
- Family background and poverty lead to learners coming to school with inadequate learning material such as calculators, and sometimes are unable to attend extra lessons;
- Teaching too much content within a short period of time, resulted in poor understanding of concepts by the learners;
- Due to lack of functional laboratories, learners end up knowing only theory but lack experience in doing practical work;

- The issue of progression is another barrier of high performance. Despite the learner not performing well in Grade 10 Physical Science, he or she may qualify for progression to Grade 11, then Grade 12, and this would ultimately result in poor performance in Grade 12 final examinations.

Learners mentioned the following causes of poor academic performance in Physical Science. They are summarised next:

- Fear to ask questions due to poor learner-teacher relationship.
- Failure to perform equally on both physics and chemistry.
- Inability of teachers to explain concepts in a simple and understandable manner.
- Teachers are promoted to other schools or districts and leave their schools and learners without a teacher. Learners may also get frustrated with the newly appointed teacher if they are unable to adapt to his/ her style of teaching.

#### 4.2.1.9 Theme 9: Suggestions for improvement

A wide range of suggestions were provided by the learners, and these include the following responses:

**Teacher responses**

*We definitely need more resources and an improved laboratory (T3m).*

*Parents need to realise their children cannot do all the domestic work at home (T4m).*

*Parents need to try and provide a study corner at home (T2m).*

*More time must be allocated to Physical Science on the school's timetable (T1m).*

*The Grade 5-10 teachers need to be properly trained to upgrade their Physical Science qualifications (T4m).*

*Tertiary institutions must become involved by doing hybrid teaching and this will encourage learners to study (T3m).*

**Learner responses**

*Learners should do more practical work in order to understand the Physical Science concepts (L5f).*

*Learners should practise more questions from past examination papers (L7f).*

*Learners should study very hard and be dedicated to their work (L9f).*

*There must be an improvement in the learner-teacher relationship so that it can be easy for learners to ask questions to teachers (L13f).*

*Learners must be encouraged to watch television learning channels (L4m).*

*Learners must attend extra classes such as morning and afternoon study groups (L1f).*

*The DoBE must supply sufficient resources to facilitate teaching and learning (L6m).*

*The school must encourage and support peer learning (L2f).*

*Teachers must have the passion to teach Physical Science (L10m).*

*Parents must not force their children to do Physical Science (L9f).*

*Physical Science learning periods should be extended (L6m).*

## 4.3 CLASSROOM OBSERVATIONS

Classroom observation was conducted at three township schools during Physical Science lessons of Grades 11 and 12. The observation schedule was used to record all the relevant observations.

The following aspects were observed during class visits.

### 4.3.1 Learning of Physical science

#### 4.3.1.1 Resources

The Grade 12 teachers from the three schools were using smart boards with Power Point presentations, electronic lessons and videos as teaching aids, textbooks, and worksheets as teaching and learning material. The laboratories were however not fully equipped, and that some chemicals and apparatus were missing.

#### 4.3.1.2 Lesson introduction

The teacher gave feedback of the test to learners and referred back to the activity and answered the question with explanations and analysed the question. He also showed them how marks are allocated per question.

#### 4.3.1.3 Learner participation

The teachers made sure that all learners participated by directing questions to individuals and also demonstrated that he knew all the learners by their names, and hence, their strengths and weaknesses. Learners were free to ask questions, an indication that the learner-teacher relationship was good.

#### 4.3.1.4 Lesson presentation

The teacher emphasised how they must use equations correctly. Learners were answering the questions with confidence. Classwork and homework were given and self or peer assessment was encouraged. The teacher further gave learners more tests and activities to test their understanding. Learners were focused and disciplined in class. Teachers controlled the learners' books. The teachers emphasised the importance of understanding the question prior to attempting to provide an answer. The teacher also emphasised that leaners should know the meaning of the key words and knowing the conditions that apply to that particular topic.

#### 4.3.1.5 Challenges

During my school visit I discovered that one of the three schools were attacked by criminals at night and stole the Smart board and electronic teaching material, and the teacher had to use a white board and the textbook to teach. There was a high crime rate in township schools which resulted in the theft and destruction of infrastructure which may therefore be one of the barriers to high performance in Physical Science. It was also surprising to me that neither teachers nor learners mentioned crime as a barrier. Observations therefore revealed additional causes of poor performance.

#### 4.3.1.6 By the end of the lesson

The teachers encouraged learners to be independent. He emphasized the importance of understanding the content (theory) in their textbook. He gave them an activity that required theory from the textbook. My impression was that the learners were strongly motivated, and were eager to search and find solutions to various problems. They operated independently which was a good sign since it implied that they would also be able to solve their own problems if they had to do so of their own accord.

### 4.3.2 Performance in Physical Sciences

The final Physical Science Matric results for School A, B, and C was 100%, 97% and 91%, respectively, in the year 2018. However, this fell short of quality as the learners hardly exceeded level 5 in Physical Science. This was revealed as an area of poor performance that needed attention.

### 4.3.3 Barriers in Physical Science

My general observation was that all three township schools had somewhat dysfunctional Physical Science laboratories due to lack of chemicals and apparatus. As a result, it is not always possible to do practical work, so practical work may only be reserved for formal tasks. Based on the 2018 matric results, most learners can only achieve level 5 and below, and this decreases their chances of being accepted in the Science faculties at tertiary level. Therefore, the insufficiency of resources and high crime rate must be addressed for matric results to improve in township schools.

## 4.4 Conclusion

Despite numerous challenges mentioned by both teachers and learners in the current study, there are quite a few aspects that stood out as major barriers of high performance in Physical Science, especially in township schools with a high pass rate in Grade 12 in South Africa.

The findings from the current study strongly indicates that one of the major barriers is the nature of the curriculum for Physical Science. It is packed in such a way that teachers are struggling to complete the prescribed topics, and consequently there is not enough time to do revision. The learners are swamped with too much work and most of the time homework is not done. There is also a tendency for some learners either not understanding or they are very weak in abstract thinking and application of Physics laws, hence they prefer Chemistry. Very often, the dysfunctional laboratories put learners at a disadvantage as they are unable to fully conduct practical work. Parents compelling learners to do the Physical Science at senior level despite having failed the subject in Grade 10 also contributes as a barrier to high performance in Physical science.

# CHAPTER 5

## FINDINGS, FINAL CONCLUSION AND RECOMMENDATIONS

### 5.1 Introduction

The chapter presents a summary of findings, conclusion and recommendations that emerged from the study. The main aim of the study was to investigate barriers to high performance in Physical Science among learners in township schools. Recommendations aimed at breaking the barriers in Physical science based on the analysis of data are discussed and further research on barriers is recommended.

### 5.2 Summary of the findings

The current study identified a few major barriers to high performance in Physical Science from the three township schools in Tshwane West district, and these include inability to finish Grade 12 curriculum in time, parents forcing learners to do Physical Science in the senior grades (particularly in Grades 11 and 12), lack of motivation, negative learners, poverty, crime and dysfunctional Science laboratories.

#### 5.2.1 Curriculum

Whilst the Physical Science curriculum is all-embracing and interesting, the time allocated to cover all topics is not enough. “The Cognitive Load Theory maintains that poor learning performance can be attributed to an overloaded of information in a short period of time, because the working memory can only process a few new elements and can store them for a short period of time only” (Anthony & Artino, 2008; Merrienboer & Sweller, 2005:148; Kirschner et al., 2009). “Successful learning occurs when the learner’s working memory is able to process new information and to store it in schemas so that more space can be made available for new information” (Anthony & Artino, 2008).

The deprived Physical Science learners facing multiple challenges in township schools need more time to grasp the content while on the other hand teachers are guided by the CAPS document to teach that particular topic and finish it in a specific (prescribed) time. This causes gaps in teaching and learning Physical Science, with only the intelligent learners who are able to keep up with the workload within the limited time allocated. Very often, the curriculum has to be covered in a short period that leaves most learners behind the Annual Teaching Plan. That creates a major barrier to high performance in Physical science. Whilst it could be argued that the same challenges exist in well-resourced model C schools, other factors (e.g., poverty, crime and dysfunctional science laboratories) which are unique to township schools exacerbate the problem. The quality of results are negatively affected due to lack of understanding all the work and not finishing the curriculum due to insufficient time allocated to Physical science before writing the final examination.

### 5.2.2 Parents

The parents often want their children to do Physical Science and Mathematics in senior grades irrespective of their poor competency in the subject. According to Trends in International Mathematics and Science Study (TIMSS), South African schools are among the most underperforming in Mathematics globally. In South Africa, Hernandez et al. (2013) also found that there was tendency for Physical Science subjects to be imposed by parents on learners at secondary schools even if such learners are underperforming in Mathematics. Very often, these are the same learners that end up being demoralised, and tend to withdraw from the subject by not doing homework, not attending extra classes, and often coming late to class due to lack of interest in the subject. Once learners are absent during the lesson, teaching and learning continue in their absence and, and thus they fall behind in their school work (Muzah 2011:200, Cho et al., 2012:169). Parents should therefore ensure that learners attend school full-time as they would not be able to catch up should they fall behind. Learners who need extra assistance and support cause a delay in the available time spent on teaching and learning, since the teacher must attend to them by teaching the sections they missed. All these aspects contribute to poor performance in Physical Science.

### 5.2.3 Lack of motivation

Physical Science is known as a challenging subject so learners need to be motivated to work hard at all the times. According to Mervis (2011), it takes a successful school first to produce good Physical Science and Maths results. A successful school must have skilled and knowledgeable teachers who are able to address a wide range of needs of all learners in a supportive, resource-rich environment. An inspired teaching staff instil the necessary discipline to learners so that they can work hard and succeed. Teachers must teach with enthusiasm to motivate the learners in order to stimulate interest in challenging subjects such as Physical Science and Mathematics. Whilst most of the Grade 12 learners have a good relationship with their Physical Science teachers, and are free to ask questions during the Physical Science lessons and during extra classes, a few were observed to be shy due to poor learner-teacher relationship. Shy learners unfortunately end up losing interest and hope in achieving good results in Physical Science.

### 5.2.4 Learner progress

The Assessment policy (2015) in the FET phase allows the learners to repeat a grade only once in the FET phase and progress to the next grade. The implementation of this policy created problems to the Physical Science teachers since learners that failed the subject in Grade 10 often reject advice to change their subject. There is a tendency for such learners not to want to participate in any class activities, since they know that this policy would allow them to move to the next grade without any effort. The worst part is that the progressed learners often fail to attend extra lessons so that the teachers could assist them, resulting in the drop of quality of Science results in Grade 12.

The issue of progressed learners who are poor performers in Physical Science need to be addressed, otherwise this will continue impacting negatively on the matric results. Moreover, Physical Sciences teachers should always attempt to give individual attention to learners as this would assist them to understand the level of knowledge that the learner has in the subject, and possibly allowing the teacher to make the necessary intervention to improve the learner's understanding of the subject.

### 5.2.5 Poverty

Poverty is so serious in Township schools in such a way that some learners go to school with empty stomachs, hoping that some food will be served by feeding scheme. Some of these children go to school without learning material and this creates a problem for the teacher who has to improvise on teaching learners without books and stationary. Ngema (2016) also identified poverty as one of the factors which contributes to poor performance. According to Lacour and Tissington (2011:522), poverty is a measure of how long a person can survive despite a lack of resources (social capital, human relationships, emotional support, financial capital as well as knowledge). Chinyoka and Naidu (2014:223) opined that the household is the learners' first point of reference to education and the acquisition of other basic needs and social skills.

### 5.2.6 Practical work

The teachers from the three township schools mentioned that their laboratories are not well equipped with chemicals and apparatus. Learners are lacking practical work while some tend to prefer Chemistry compared to Physics. Practical work is very essential as it helps learners to put theory into practice, making the subject clearer and understandable. The poor-resourced laboratories severely impede practical work, thereby generally affecting the performance of Physical Science learners at all levels Stone (2007:39).

## 5.3 Research questions answered

### Main research question

What are the barriers to high learner performance in Physical Science in township secondary schools?

The barriers to high school education surfaced as poverty and financial problems. Many parents battle to make a living and have to involve their children with household chores. Even though these parents do want their children to progress in school, they need help around the house. Space also featured as a problem, since learners do not all have their own learning space at home. Furthermore, a lack of resources at school featured as a prominent obstacle to learning Physical Science. If the needed equipment and chemicals are not available in the laboratory, it is very difficult to do experiments. These experiments are then done theoretically and learners do not have the privilege of observing these activities practically.

**Sub questions**

- How do learners learn Physical Science in high performing township secondary schools?

The evidence from observations and interview data revealed that learners engage in theoretical reception instead of learner-centred practical involvement. This poses a serious hindrance in their learning which is reflected in the poor Physical Science marks.

- What are the barriers of high learner performance in learning Physical Science in township secondary schools?

The main barriers were embraced in the first research question, but a fact that could be observed as a serious hindrance was the lack of chemicals and apparatus in the laboratories, and the inadequate teaching and learning environment that promotes learner-centred learning. A lack of financial support was also mentioned as one of the barriers to high learner performance. The problem regarding the shortage of funds also featured in the home environment, since learners have to assist their parents by selling vegetables at home over the weekends, thus diverting their attention away from their academic work.

## 5.4 Recommendations

Based on the findings of the current study on barriers of high performance in Physical Science in township schools in South Africa, the researcher recommends that:

- The Department of Education (Curriculum Developers) must review the Physical Science curriculum, particularly with the view of reducing the number of topics covered in Grades 11 and 12. This will improve learning and teaching of the subject as they would be enough time to finish and revise the work, thereby benefitting some learners with fewer capabilities;
- The schools should organise the parents' meeting for all the parents that want their children to study Physical Science as a subject and explain to them the criteria and the policy which allows or disallows learners to do Physical Science in the senior grades/ FET phase. Hopefully, once they understand the criteria, they would be discouraged to make subject choices for their senior grade learners;
- Parents should accept the teacher's advice and be willing to support the school;
- The schools should invite motivational speakers to address the learners on how to succeed against all odds;
- The assessment policy in terms of progressed learners must be reviewed to avoid poor results at the end of Grade 12;
- Poverty and crime must be attended to as learners cannot learn when they are hungry. Theft and vandalism of infrastructure negatively impact on learning and teaching of complex subjects such as Physical Science. Although feeding schemes serve as solutions to the poor, these lower the dignity of the learners and are sometimes unsustainable. Job creation in the townships will go a long way in addressing poverty in in these areas; and
- Schools should look for sponsors to buy chemicals and apparatus to help learners to do practical work.

**5.5 Further research**

Although the study achieved its goal of identifying the major barriers of high performance in Physical Science in three selected township schools, further studies should be conducted to:

- find out how the re-design (e.g. reducing the number of topics covered in Grade 11 and 12) of the Physical Science curriculum can improve the performance of Grade 12 learners and boost their chances of success at tertiary level; and

- identify ways and means of closing the teaching and learning gap when Physical Science teachers take up promotional posts in other schools or districts.

## 5.6 Conclusion

This study identified major barriers of high performance in Physical Science in the three township secondary schools in South Africa. The study also attempted to make recommendations aimed at breaking the barriers, and thus improving the performance of Physical Science learners at FET phase. It was clear that barriers to high performance is multifaceted and require cooperation among major stakeholders. For example, parents must provide educational support and assist their children to make the right subject choices for learners. The DoBE should re-design the curriculum and law enforcement must deal with the high crime rate which results in the demise of the infrastructure.

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## APPENDIX A

UNISA university of south africa

### UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2018/10/17

| |
|---|
| Ref: **2018/10/17/32063512/27/MC** |
| Name: Mrs. TT Simelane |
| Student: 32063512 |

Dear Mrs Simelane

| |
|---|
| **Decision:** Ethics Approval from 2018/10/17 to 2021/10/17 |

**Researcher(s):** Name: Mrs TT Simelane
E-mail address: Simelanetrusty@yahoo.com
Telephone: +27 71 881 3815

**Supervisor(s):** Name: Dr MP Rankumise
E-mail address: RankumiseMP@tut.ac.za
Telephone: +27 82 687 6644

| |
|---|
| **Title of research:** |
| **Barriers to high performance in physical science among students: case of selected township secondary schools in South Africa** |

**Qualification:** M. Ed in Science and Technology Education

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 2018/10/17 to 2021/10/17.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2018/10/17 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.

APPENDIX B

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

## GDE AMENDED RESEARCH APPROVAL LETTER

| | |
|---|---|
| Date: | 07 November 2018 |
| Validity of Research Approval: | 04 February 2019 – 30 September 2019<br>2018/301A |
| Name of Researcher: | Simelane TT |
| Address of Researcher: | P O Box 12247 |
| | Queenswood |
| | 0121 |
| Telephone Number: | 071 881 0381 |
| Email address: | Simelanetrusty@yahoo.com |
| Research Topic: | Barriers to high performance in physical science among students: case of selected township secondary schools In South Africa. |
| Type of qualification | M.ED |
| Number and type of schools: | Three Secondary Schools. |
| District/s/HO | Tshwane North, Tshwane West |

***Re: Approval in Respect of Request to Conduct Research***

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

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

08/11/2018

1

*Making education a societal priority*

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

**APPENDIX C**

**GAUTENG PROVINCE**
EDUCATION
REPUBLIC OF SOUTH AFRICA

Enq: MK Majola
Tel: 012 725 1373
Ref no: 8/4/4/1/2

---

| | |
|---|---|
| **To:** | **The Principals**<br>**Pelotona, Tebogwana and Tswaing Secondary Schools** |
| **From:** | **P Galego (Ms)**<br>**District Director** |
| **Date:** | **04th February 2019** |
| **Subject:** | **Request to Conduct Research: Simelane TT** |

---

Please note that Simelane TT has been granted permission by Head Office to conduct research at the above-named schools. The exercise is scheduled for academic year 2019.

The school principals and SGB members are kindly requested to welcome the researcher.

Research Topic: **"Barriers to high performance in Physical Science among students: case of selected township secondary schools in South Africa"**

Please ensure that teaching and learning process is not negatively affected.

**P Galego (Ms)**
**District Director**
**Tshwane West**

"Unleashing all Potential"
**Office of the Director – Tshwane West District**
(Mabopane, Winterveldt, Ga-Rankuwa, Soshanguve, Kameeldrift, Rosslyn, Akasia, Pretoria North, Mountain View, Roseville, Capital Park, Hercules, Pretoria West, Lotus Garden)
Private Bag X38, ROSSLYN 0200. Tel (012)725 1300 Fax (012) 725 1346
Paula.Galego@gauteng.gov.za; Web. www.education.gpg.gov.za

APPENDIX D


Dr C.G.A. SMITH

PhD (English)

Language practitioner: editing and proofreading

Cell: 0727661428


This is to certify that the following document has been language edited:

| |
|---|
| ***BARRIERS TO HIGH PERFORMANCE IN PHYSICAL SCIENCE AMONG LEARNERS: A CASE OF SELECTED TOWNSHIP SECONDARY SCHOOLS IN SOUTH AFRICA*** |

**Authors:** T.T Simelane

**Nature of the document:** Postgraduate work

**Date of this statement:** 8 September 2019

Smithcga

# APPENDIX E: OBSERVATION SCHEDULE

Grade: ______________________________
Topic: ______________________________
Date: ______________________________
Time: ______________________________
Name of the teacher: ______________________________
Name of the School: ______________________________
Number of learners in Class: ______________________________
Matric pass rate in physical sciences: ______________________________

**<u>RESOURCES</u>** Comments

| | | | |
|---|---|---|---|
| 1. Textbooks | Yes/No | | |
| 2. Laboratory | Yes/No | | |
| 3.E- Learning | Yes/No | | |
| 4.Other<br>Please specify | Yes/No | | |
| | | | |

<u>CLASSROOM OBSERVATION</u>

*Introduction of the session*

| **How well did the teacher** | **Very well** | **Well** | **Not very well** | **Not applicable** |
|---|---|---|---|---|
| • secure attention of the learners? | | | | |
| • introduce subject in an interesting way? | | | | |
| • make the aims of the session clear to learners? | | | | |
| • link subject to previous sessions? | | | | |
| • set tasks appropriately and allocate responsibilities? | | | | |
| • define the topic for discussion? | | | | |
| **Overall**, this session was conducted | | | | |

**Comments**

| |
|---|
| |

*Explanation of the subject*

| **How well did the teacher** | **Very well** | **Well** | **Not very well** | **Not applicable** |
|---|---|---|---|---|
| • demonstrate a firm grasp of the subject area? | | | | |
| • adopt a logical structured approach? | | | | |
| • provide alternative explanations of difficult points? | | | | |
| • make good use of audio-visual materials? | | | | |
| • make good use of learners handouts? | | | | |

| | | | | |
|---|---|---|---|---|
| • use relevant examples and topical illustrations? | | | | |
| **Overall**, this session was conducted… | | | | |

**Comments**

*Presentation of the session*

| **How well did the teacher** | **Very well** | **Well** | **Not very well** | **Not applicable** |
|---|---|---|---|---|
| • use legible and clear audio-visual material? | | | | |
| • show enthusiasm/ | | | | |
| • speak clearly and concisely? | | | | |
| • make eye contact with students? | | | | |
| • maintain an appropriate level of class control and discipline? | | | | |
| **Overall**, this session was conducted… | | | | |

**Comments**

*Learner participation and interaction*

| **How well did the teacher** | **Very well** | **Well** | **Not very well** | **Not applicable** |
|---|---|---|---|---|
| • use questions/demonstrations to clarify understanding and involve learners? | | | | |
| • handle learners questions and responses appropriately/ | | | | |
| • respond positively to and build on incorrect answers | | | | |
| • encourage reasoned argument? | | | | |
| • give support and guidance to help learners with difficulties? | | | | |
| • keep learners involved and maintain learner interest? | | | | |
| • monitor learner progress during the session? | | | | |
| • use layout of the room effectively? | | | | |
| **Overall,** this session was conducted… | | | | |

**Comments**

*Ending the session*

| How well did the teacher | Very well | Well | Not very well | Not applicable |
|---|---|---|---|---|
| • reiterate and summarise key points? | | | | |
| • summarise the discussion? | | | | |
| • give clear instructions for follow up work? | | | | |
| • identify link with following session? | | | | |
| • end the session positively and clearly? | | | | |
| **Overall**, this session was conducted… | | | | |

**Comments**

**Overall comments:** including reference to any issues affecting the session which were outside the control of the teacher
e.g. resources, infra-structure

# APPENDIX F: TEACHERS INTERVIEW QUESTIONS

**TEACHERS QUESTIONS**

1. Tell us more about your teaching experience in terms of:
    - number of years teaching Physical sciences.
    - performance of learners for the past three years (pass percentage and symbol distribution.)

2. What is your highest qualification in the subject?
3. What is your view in terms of the performance of learners in Physical sciences at your school?
4. What are the challenges that you have encountered while teaching this learners?
5. Do you regard your school as a well-resourced or poorly resourced school?
6. Do you enjoy teaching Physical Sciences?
7. What are your goals in teaching Physical Sciences?
8. How do you motivate your Physical science learners to do better in the subject?
9. What do you think are the barriers of high performance in Physical science at your school?
10. If you were asked by the district officials to suggest ways in which the quality of results can be improved, what suggestions would you put forward?

# APPENDIX G: LEARNERS INTERVIEW QUESTIONS

UNISA university of south africa

**LEARNERS QUESTIONS**

1. After completing Matric, what are you going to study at the tertiary Institution?
2. What are your goals in Physical Sciences?
3. Do you enjoy learning Physical sciences? If the answer is no, state reason/s why?
4. Is there anything that can make it difficult for you to pass (achieve your goal) Physical Sciences?
5. How would you describe your relationship with your Physical Science teacher?
6. Where do you see yourself in five years' time?
7. How do you rate your performance in Physical Sciences?
8. What do you think should be done to improve learner performance in Physical Sciences?
9. What kind of support do you receive from your parents regarding your school work?

**APPENDIX H**

UNISA university of south africa

## Teacher Biographical Information

| |
|---|
| 1. Name of school (pseudonym): |

| |
|---|
| 2. Name of Teacher (pseudonym) : |

**Place X in appropriate boxes**.

3. Gender

| | |
|---|---|
| Male | |
| Female | |

4. Age

| | |
|---|---|
| Less than 30 years | |
| Above 30 years | |

5. Teaching qualification

| | |
|---|---|
| Grade 12 | |
| Certificate in Education (CE) | |
| Diploma in Education (Dip. Ed) | |
| Advanced Certificate of Education (ACE) | |
| Bachelor of Education (BEd) | |
| Bachelor of Education (BEd) Hons. | |
| Master of Education (MEd) | |
| Doctor of Philosophy (PhD) | |

6. How many years have you been teaching Physical Sciences in Township schools?

| | |
|---|---|
| Less than 1 year | |
| 3 - 5 years | |
| 6 - 10 years | |
| More than 10 years | |

7. Which province(s) you been teaching Physical Sciences in Township school?

| | |
|---|---|
| Gauteng | |
| Limpopo | |
| Mpumalanga | |
| KwaZulu Natal | |

8. How many learners obtained level 5, 6 & 7 at your school?

| | |
|---|---|
| Level 5 | |
| Level 6 | |
| Level 7 | |

**Thank you for your participation**

## APPENDIX I: PERMISSION LETTER REQUESTING PARENTAL CONSENT FOR MINORS TO PARTICIPATE IN A RESEARCH PROJECT

**Dear Parent**

Your child is invited to participate in a study entitled, “Barriers to high performance in Physical Science among learners: A case of selected Township secondary schools in South Africa”
I am undertaking this study as part of my master’s research project at the University of South Africa. The purpose of the study is to identify the barriers of high performance in Physical sciences and the possible benefits of the study is the improvement of the Matric Science results. I am asking permission to include your child in this study because he/she is doing Physical Sciences, and he/ she will participate with other children in the same class.

If you allow your child to participate, I shall request him/her to take part in an interview afterschool at his/her class for 15 minutes and it will be recorded digitally only.

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 are no foreseeable risks to your child by participating in the study. Your child will receive no direct benefit from participating in the study. However, possible benefits to education will be improved results in Physical science. 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. 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, Dr. Rankhumise, Department of Science and Technology, College of Education, University of South Africa. My contact number is 0718810381 and my e-mail is Simelanetrusty@yahoo.com. The e-mail of my supervisor is rankhumisemp@tut.ac.za. Permission for the study has already been given by the Gauteng Department of Education and the Ethics Committee of the College of Education, UNISA.

If you allow your child to participate in this study, please sign below to indicate that you have read the information provided above and have allowed 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: |
| T.T Simelane | | 2019/2/19 |
| Researcher's name (print) | Researcher's signature | Date: |

## APPENDIX J: A LETTER REQUESTING ASSENT FROM LEARNERS IN A SECONDARY SCHOOL TO PARTICIPATE IN A RESEARCH PROJECT

Title of your research: entitled Barriers to high performance in Physical Science among learners: A case of selected Township secondary schools in South Africa.

Date 2019/2/18

Dear Learner

I am doing a study on barriers to high performance in Physical Science among learners as part of my studies at the University of South Africa. Your principal has given me permission to do this study at 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 teach you 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. Should there be some words you do not understand in this letter, feel free to ask me or any other adult to explain. You may take a copy of this letter home to think about my invitation and talk to your parents about this before you decide to participate in this study. I would like to ask questions about your physical science as a subject for about 15 minutes.

Participation is voluntary and you do not have to be part of this study if you don't want to. If you choose to participate in the study, you may stop taking part at any time without penalty. It is within your right not to answer some of the questions, so feel free to tell me if you do not wish to answer any of the questions.

After the interview, I will write a report on this study but I will not indicate your name in the report or say anything that will let other people know who you are. I will make this report available to your

school, and will give a short talk about some of the helpful and interesting things I found out in my study. I shall invite you to come and listen to my talk. There are no foreseeable risks by participating in the study, and you will receive no direct benefit from participating. You will not be reimbursed or receive any incentives for your participation in the research.
However, possible benefits to education will be better results in Physical science should the findings of my study be implemented.

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 0718810381.
Do not sign the written assent form if you have any questions. Ask your questions first and ensure that all your questions are answered.

**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 am willing to participate in 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: |
| T.T Simelane | ___________________________ | 2019 /2/18 |
| Researchers name (print) | Researcher's signature: | Date: |

## APPENDIX K: CONSENT FORM FOR TEACHERS

**CONSENT 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 my participation.

I have read (or had explained to me) and understood 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. 1

I agree to the recording of the interview and classroom lesson.

I have received a signed copy of the informed consent agreement

Participant Name & Surname (please print) _____________________________________

____________________________ ___________________________________

Participant Signature Date

Researcher's Name & Surname (please print) _T.T Simelane

________________________ ________2019/02/18__________________________

Researcher's signature Date