Contributory factors to poor learner performance in Physical Sciences in KwaZulu-Natal Province with special reference to schools in the Pinetown District

by

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DECLARATION

Student number: 4348- 616-9

I declare that **Contributory factors to poor learner performance in Physical Sciences in KwaZulu-Natal Province with special reference to schools in the Pinetown District** is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE DATE

(Ms T Dhurumraj)

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ABSTRACT

The National Senior Certificate Examination results for Physical Sciences have recently declined, particularly in the province of KwaZulu-Natal. This study identified the causes of poor learner performance in Physical Sciences in grade 12 in the Further Education and Training (FET) phase in public schools in the Pinetown District, KwaZulu-Natal. The study employed a quantitative as well as a qualitative approach. Two public schools in the Pinetown District participated in this study. The identities of all respondents were protected. Upon analysis of the results, several contributory factors for poor performance were identified; no single factor was accountable for poor performance in Physical Sciences. Recommendations for improvement in the areas identified were provided and topics for future research on the curriculum of grade 8 and 9 Natural Science were suggested.

KEYWORDS

learner performance, physical science curriculum, parental involvement, socio-economic status, home language, class size, resource availability

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CHAPTER 1
BACKGROUND TO THE STUDY

1.4 INTRODUCTION

For the past number of years South Africa has seen a gradual decrease in the National Senior Certificate results for the subject Physical Sciences. South Africa's poor performance in Physical Sciences can be seen both nationally and internationally. In 2001 and 2003 the Trends in Mathematics and Science Study (TIMSS) was conducted globally and South Africa was part of this study (Howie 2003). In 2001 38 countries participated in the study with a view to determining learner performance in the sciences; in 2003 58 countries participated and in both instances South African learners were placed last (Makgato & Mji 2006:253). From 2005 to 2007, the number of learners who passed Physical Sciences at the higher grade level has steadily decreased and this has affected their entry into science based programmes at universities (Kriek & Grayson 2009:185). According to Kriek and Grayson (2009: 185-186), in 2005 a total of 29 965 learners passed Physical Sciences, in 2006 this figure dropped to 29 781 and in 2007 it dropped to an alarming 27 122 learners who passed Physical Sciences. Clearly South African learners are not performing in the science field.

In the 2009 Senior Certificate results, the national pass rate for Physical Sciences dropped from 55% to 37%. In 2009 all nine provinces across South Africa recorded a decline in Physical Sciences. The most alarming decline was in KwaZulu-Natal where the pass rate in Physical Sciences halved compared to the previous year (Keeton 2010). The poor performance of learners in Physical Sciences is a serious cause for concern considering the fact that KwaZulu-Natal traditionally provides a high number of successful maths and science students.

A number of possible factors contribute to the poor performance of learners in Physical Sciences. Based on my own experience over the last four years, learning Physical Sciences is more challenging for African learners who are English second language speakers and attend English medium schools. Due to the legacy created by segregation and differentiated schooling systems the majority of parents of grades 10, 11, and 12 learners lack English proficiency. This makes it difficult for them to assist their children in the Physical Sciences related tasks.

Physical Sciences is a subject with an extensive quantitative component. Cognitive prerequisites for Physical Sciences involve scientific as well as analytical thinking. Hence learners require mathematical and problem solving skills. However, many learners at grade 12 level take Physical Sciences and mathematics literacy as a combination with the view to tertiary education. Mathematics literacy is not as complex as pure mathematics and merely provides learners with a general background in mathematics, which differs from pure mathematics.

From my own experience as a grade 12 Physical Sciences educator, learners who take Mathematical Literacy lack the skills required to investigate physical phenomenon and conduct quantitative investigations. As a developing country, South Africa has the potential for great achievement in the science and technological sectors and evidence of this is South African Largest Telescope (SALT) situated in Sutherland (Kelder 2007:35-110). The South African Largest Telescope is the greatest single optical telescope project in the southern hemisphere and among the largest in the world. These achievements contribute to the economic sector and are a step closer to becoming a developed country.

Physical Sciences as a subject is important as it focuses on investigating physical and chemical phenomenon through scientific enquiry, as can be seen in SALT project above. Through the application of scientific models, theories, and laws it seeks to explain and predict events in the physical world. This subject also looks at how society can benefit from the environment, care for it and use it responsibly (Department of Education 2003).

Since 2008 the KwaZulu-Natal Senior Certificate pass rate has fluctuated between 57,8% and 61,1% in 2009. In 2010 61,1% of grade 12 learners passed the Senior Certificate examination; in 2011 the pass rate increased to 68,1% (Daily News 2012:2). The pass percentage in Physical Sciences in 2011 was 51,9% and in 2012 it was 53,3% (Department of Education 2012b).

Furthermore, even if grade 12 learners in KwaZulu-Natal pass the Senior Certificate, they are unlikely to obtain admission to Bachelors studies. In 2010 only 26% of 122 444 learners enrolled at schools in the KwaZulu-Natal province managed to obtain university entrance (Department of Education 2010). The situation was even worse in 2011 when 53,4% of learners who passed Physical Sciences (obtaining between 30% to 40%) could not access tertiary education (Department of Education 2012a). A 30% pass is a low standard by measure. Universities accept a 40% pass; better universities offering programmes in the health and science fields only select students which much higher passes (City Press 2011:18). In 2011 only 22,4% of grade 12 learners who passed Physical Sciences obtained admission to institutions of higher learning (Department of Education 2012b). Thus, attaining40% cannot be regarded as an automatic admission to tertiary education.

Most learners in KwaZulu-Natal are found in the Pinetown District. The Pinetown District comprised 334 672 learners in 2010 and is still regarded as one of the largest education districts in KwaZulu-Natal. The district had the highest number of learners (140 873) in 2010 in the Further Education and Training phase (Department of Education 2010:19).

1.2 PROBLEM FORMULATION

In the light of the above discussion, the main research question is formulated as follows: *What are the contributory factors for the poor performance of learners doing Physical Sciences in the FET phase in public schools in the Pinetown District, KwaZulu-Natal?*

The main research problem can be divided into the following sub-questions:

1. What are the experiences and perceptions of teachers regarding the teaching of Physical Sciences in grade 12? What are the challenges teachers experience when teaching Physical Sciences?

2. How does the medium of instruction affect the performance of grade 12 Physical Sciences learners whose first language differs from the language of learning and teaching (LoLT)?
3. What recommendations can be made based on the literature review and the findings of the empirical study for the improvement of learner performance in Physical Sciences?

1.3 AIMS OF INVESTIGATION

The main aim of the study is to investigate contributory factors that influence learner performance in Physical Sciences in the FET Phase in public schools in the Pinetown District, KwaZulu-Natal.

The main aim can be sub-divided into the following objectives:

1. To explore the experiences and perceptions of Physical Sciences teachers regarding poor performance of science learners in grade 12.
2. To investigate how the LoLT affects grade 12 Physical Sciences learners' performance whose first language differs from the LoLT.
3. To make recommendations based on literature review and the findings of the empirical study for the improvement of learner performance in Physical Sciences.

1.4 RATIONALE FOR STUDY

Although this study is limited to Physical Sciences teachers, learners and subject specialists, the results of this study provide insights not only about the reasons of poor performance in Physical Sciences but also about the problems faced by teachers and learners during the Physical Sciences teaching-learning process. The results of this study suggest possible solutions to make science teaching and learning more meaningful to learners and teachers. The study further aims at suggesting ways to eliminate problems which continue to detract from the performance of Physical Sciences learners in grade 12. The value and importance of science is increasing yet the pass rate in grade 12 in Physical Sciences has shown very little or no improvement in some of the public schools in the Pinetown District. A number of factors contribute to the failure rate and the numbers of learners who pass but do not obtain university entrance.

1.5 RESEARCH METHODOLOGY

1.5.1 Choice of research design

A mixed research design was used. In this design both quantitative and qualitative data were collected at approximately the same time. The research design included a non-experimental design and a survey design type using q questionnaire and interviews and personal observations.

1.5.2 Data Sources

Both primary sources (e.g., articles, dissertations, class registers, and statistics of Senior Certificate results) and secondary sources (e.g., books) were used.

1.5.3 Data Sources

Data collection involved the use of several data collection tools. Both quantitative and qualitative techniques were used during this study, as it strengthened the study by providing triangulation. The approaches that I used in this study towards the data collection involved experiencing, enquiring and examining.

Questionnaires were used to get personal information (age, gender, race, home language, and years of teaching experience or attending tuition, learner participation in pure mathematics or mathematics literacy) from educators and learners. I chose the survey because I am interested in the learners' views, beliefs, ideas and fears about Physical Sciences as a subject. Surveys are used in various sectors such as education, politics, government and social studies, since accurate information can be obtained for a large number of people by just using a small sample (McMillan & Schumacher 2006:223). The incidence, distribution and frequency for a large population can be described by using only a small sample of participants from that population with surveys (McMillan & Schumacher 2006:223). Surveys are versatile, cost effective and efficient. In this study, questionnaires were printed and distributed to all learners during a registration period or break, thus saving time and not disrupting the teaching and learning process.

Interviews were also used to collect data. The advantage of interviews is that the interviewer can adapt the questions (if necessary) during the interview process (McMillan & Schumacher 2006:203-206). Also signs of non-verbal communication can be observed and taken into account. Interviews allow for the interviewer to probe and get a clearer response to questions; and the questions for interviews can be structured, semi-structured or unstructured (McMillan & Schumacher 2006:203-206). Questions can be adapted during the interview process. All interviews were conducted in the lunch breaks and minutes were taken. Analysis of examination results was also done.

1.5.4 Issues of reliability and validity

To ensure validity, both internal and external validity were taken into account. Internal validity refers to factors that may affect the relationship between the dependent and the independent variable. External validity refers to the generalizability of the results (McMillan & Schumacher 2006:141). The two factors of external validity that had to be taken into account were population external validity (subjects used have a particular characteristic e.g. they are all learners in grade 12; they were both male and female; educators were all teaching grade 12 Physical Sciences) and ecological external validity (conditions under which the experiment is carried out: is it just after a Physical Sciences examination). To maintain reliability I had to ensure that my instrument/s were free from error. In the case of the questionnaires, all questions were clearly phrased and free from ambiguity; biased items avoided; questions had to be relevant and thus ensured reliable results. The interviews consisted of structured, semi-structured and unstructured questions.

1.5.6 Population

A research population is basically a collection of individuals or objects that is the main focus of a scientific study. However, due to the large size of schools in the Pinetown District, only two schools were selected. The two schools comprised 100 learners respectively.

1.5.7 Sampling Techniques

Two under-performing schools from the Pinetown District were selected purposefully for this study. Each school had at least one Physical Sciences educator currently teaching Physical Sciences at the grade 12 level and the selected educator participated in this study. The Subject Advisor for Physical Sciences was also interviewed. Purposive sampling was also used to select learners: the Grade 12 learners doing Physical Sciences in the two schools.

1.6 DEFINITION OF CONCEPTS

For this study a variety of concepts were used, and the following definitions apply to the selected concepts and terminology:

1.6.1 Assessment

According to the National Curriculum Statement for the FET phase, assessment is a process of collecting and interpreting evidence in order to determine the learner's progress in learning and to make a judgement about a learner's performance (Department of Education 2003:55).

1.6.2 Curriculum

Curriculum as a field of study is crucial to the health of schools and society; it can be defined narrowly as subjects that are taught in school or it can be defined broadly as experiences that people require in order to be actively involved in society (Ornstein & Hunkins 2009:1).

1.6.3 Learner Performance

This refers to the learner's ability to demonstrate understanding and show that learning has taken place through an activity or task (Woolfolk 2007:562-563).

1.6.4 Outcomes-Based Education

Outcomes-Based Education forms the foundation for the curriculum in South Africa. It strives to enable all learners to reach their maximum learning potential by setting the Learning Outcomes to be achieved by the end of the education process (Department of Education 2003:2).

1.6.5 Physical Sciences

According to the Department of Education (2003), Physical Sciences focuses on investigating physical and chemical phenomena through scientific inquiry. By applying scientific models, theories and laws it seeks to explain and predict events in our physical environment (Department of Education 2003:9).

1.6.6 Poor Performance

Poor performance refers to learners obtaining marks below 30% in the National Senior Certificate Examination, and thereby failing the subject (Department of Education 2003).

1.7 LIMITATIONS OF THE STUDY

This research was limited to Physical Sciences learners in a single province in South Africa. Not all Physical Sciences learners were present at the school on the day/s the study was done and thus certain individuals who may have made an important input did not take part.The questionnaires were administered in English, the LoLT used in the two schools. However, English was the L1 of very few learners (see Chapter 4).

1.8 CHAPTER DIVISION

Chapter 1 – Background to the Study

This chapter provides the background information to the study. It introduces the study, describes the problem formulation, and discusses aims, objectives, limitations and an outline of the chapters.

Chapter 2 – Literature Review

Chapter 2 provides the theoretical background to the study. Factors that contribute to the academic performance of learners and efficient and effective teaching of Physical Sciences are presented.

Chapter 3 – Research Design and Procedures

This chapter presents the data collection methods and procedures i.e. the collection instruments used, population sampling techniques, location and demographics are all described in detail. Also included are the ethical considerations and informed consent.

Chapter 4 – Data analysis, interpretation and findings

In this Chapter, findings of the research are provided.

Chapter 5 – Synthesis of findings, final conclusion and recommendations

Findings are synthesized and final conclusion of the study is provided. Based on the study literature and the findings, future recommendations are provided.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The focus of this chapter is to review the literature on different factors that have a bearing on poor performance of learners in Physical Sciences. In South Africa several factors have contributed to the poor performance in Physical Sciences; trying to isolate a single factor is impossible. Given the imbalances of the past, location and background of the learners a range of factors can be identified. Before these factors are identified and discussed, it is imperative to deliberate on the value of Physical Sciences as a subject.

2.2 VALUE OF PHYSICAL SCIENCES

The Department of Education (2003:9) defines the value of Physical Sciences as follows: "The subject Physical Sciences focuses on investigating physical and chemical phenomena through scientific inquiry. By applying scientific models, theories and laws it seeks to explain and predict events in our physical environment. This subject also deals with society's desire to understand how the physical environment works, how to benefit from it and how to care for it responsibly" (Department of Education 2003:9). The subject Physical Sciences helps us understand the natural world through the use of observation and testing of ideas (Department of Education 2002). One of the fundamental purposes for offering Physical Sciences is that it provides learners with scientific knowledge which is embedded in science education.

Sciences education provides learners with a foundation of technical skills which are in short supply. High achievement in sciences is valued in society because it sets the precedence on academic success as the stepping stone for entrance into more prestigious occupations (Okoye 2002:561). For learners who take up Physical Sciences as a subject at school, it prepares them for tremendous opportunity at the end of their secondary education phase.

Physical Sciences play an important role in the lives of all South Africans. Its influence on scientific and technological development, which underpins our country's economic growth and the social well-being of our community (Department of Education 2003) cannot be overlooked. It also plays a role in locating a country and its citizenry in a globalised context. Physical Sciences knowledge impact on global and economic, political, ethical, environmental, social and technological issues (Department of Education 2003). Evidence of the impact that Physical Sciences has in the global community is evident in South Africa's involvement with Australia in hosting the Square Kilometre Array (SKA) that will enable scientists to answer fundamental questions about the universe.

Physical Sciences encourages a responsible and ethical attitude towards learning, constructing and applying science, and it allows for reflection and debates on theories and scientific models (Department of Education 2003). The responsibility that is encouraged by Physical Sciences is not only used by scientists but by local government and proof of this is in the statement made by the former Minister of South African Science and Technology, Naledi Pandor (in Herskovitz 2012) who stated, "There is no decision by government on that. We must understand the science before any license is given, but I will use the Astronomy Advantage Act if necessary". This statement substantiates the importance of how government consistently is guided by scientific principles before it passes legislation or takes scientifically based decisions.

2.3 IMBALANCES OF THE PAST

The history of the South African education system shows the inequalities that existed for more than a hundred years during various historical epochs. The provision of education during the colonial period and the subsequent periods were characterised by segregation and unequal resource allocation. The education that was provided for the majority of the Black people was inadequate and a better education system was needed. For the white middle class children who attended church schools, government made sure that those schools were subsidized and well-resourced (Christie 2008:29-51). Education was believed to be able to bring about social order. The government developed a free and compulsory education system for the white people. At the same time, education for Black children was neither free nor compulsory. It remained the responsibility of different mission societies (Christie 2008).

Since the early 1970’s education inequalities have been present and the effects of it on the Black people of South Africa have been devastating. The brutally vivid memories of the Soweto uprising of June 1976 where Hector Peterson died after being shot is evidence that testifies to the unequal education system that prevailed in South Africa for many years. African learners were merely demonstrating against the enforcement of Afrikaans as a medium of instruction at schools (Christie 2008). During the apartheid era, the Black population was seen as inferior and a few years of free education was regarded as sufficient to prepare Black people for labourers’ roles (Christie 2008). Even people employed as teachers were not subject specialists.

After 1994 the restructuring of the education system was aimed at providing all people in South Africa with equal opportunity. In 1994 and thereafter, several pieces of legislation were passed by government; among others, the South African Schools Act of 1996 was enacted as law. One of the several functions of the South African Schools Act (SASA) (1996d) Section 34 (1) is that the state provides and ensures access to quality education for all and redresses the past education inequalities among sections of those who suffered particular disadvantage. However, the imbalances of the past, still has a silent but crippling effect on the present generation. Prior to 1994, only a few learners took Physical Sciences as a subject in the Senior Certificate. This trend continues since relatively few learners take Physical Sciences as a core subject.

2.4 LEARNER PERFORMANCE IN PHYSICAL SCIENCES

Stakeholders at all levels wait in anticipation at the end of every academic year for the release of the grade 12 National Senior Certificate results. Over the past several years the pass rate for Physical Sciences has created cause for great concern as there has been a steady decrease in performance (Kriek & Grayson 2009). In spite of the efforts undertaken by the Department of Education (DoE), there has been little or no improvements in some public schools in KwaZulu-Natal. It is vital for learners and parents to understand that in order to succeed in Physical Sciences, a mathematical metacognition (Schoenfeld 1987) is required by the learner.

Kriek and Grayson (2009:185-186) state that the national pass rate in science learning (particularly mathematics and Physical Sciences) has decreased since 2003. Some of the variables that have contributed to the decline in the pass rate include the educators' poor understanding of the syllabus, a negative attitude and arriving late to class. Bad attitudes can be linked to a poor understanding of the policy documents that the educator is required to implement; in this case the National Curriculum Statement (NCS). The science learning field is a complex one. Physical Sciences involve experimentation which is difficult in large classes. Makgato and Mji (2006:256) mention that in the 2003 Gauteng province had a 50% failure rate in Physical Sciences at the higher grade in grade 12. These results were of great concern as Physical Sciences is considered a critical subject.

Teachers must be familiar with the subject content to be taught. Research conducted in many primary schools in Australia has shown that despite a lack of resources, many primary schools teachers did not teach Physical Sciences because of a poor understanding and thus lacked confidence to teach the subject (Appleton 2003:2). Many teachers use out-dated teaching practices and lack basic content knowledge (Makgato & Mli 2006:254). This has contributed to the poor performance of learners.

Limited resources are a factor that may affect underperformance in schools. According to Goodrum, Hackling and Rennie (2001:11), in Australia resource limitations are a significant constraint on the quality of teaching and learning. Learner performance is not solely dependent on the availability of resources but also on the effective use of the available resources by the educators (Naidoo & Lewin, 1998:729). South Africa has implemented many post-apartheid policies to address the issues surrounding science education. According to Naidoo and Lewin (1998), the focus of these policies have been on increasing investment in science education through educating more science teachers, providing more access to students to study science at schools, and supplying more science equipment to schools.

However, after their research in Kwazulu-Natal schools, they concluded that each of these policy initiatives could be questionable.

The other factor that plays a role in underperformance of learners in schools has to do with strategies that science teachers use to teach Physical Sciences. For a science learner to engage in observation as a science skill, a learner needs to see a practical situation which illustrates the lesson. The strategy of teaching Physical Sciences cannot be a text book one only. Demonstration of lessons and chemical reactions should be an integral part of the teaching and learning process in a Physical Sciences classroom. Testing of ideas is not confined to pen and paper, but rather active involvement of learners in investigative lessons (Vhurumuku 2010).

A key feature of science education is the ability of the learner to select that which is important for the task at hand and discard that which is not required (Hindal, Reid & Badgaish 2009: 199-189). According to Hindal et al (2009:189), the idea of convergency - divergency is central to science education and its learners; learners who are more divergent are able to take a concept or ideas and relate it to various other concepts and ideas, while the more convergent learner tends to bring ideas together to form some form of conclusion. Research shows that learners who think divergently perform better at chemistry (Hindal *et al* 2009:189).

2.5 THEORETICAL FRAMEWORK

This study is placed within a qualitative approach and analyses reasons why grade 12 Physical Sciences learners underperform. Therefore, the study touches on what affects performance in Physical Sciences. In the following paragraphs, I briefly present a few factors that affect performance. Performance has been defined by researchers to include multiple and interrelated variables. These variables include: learners' ability, perception and attitude, socio-economic factors, school-related variables and parent involvement (Singh, Granville, & Dika 2002).

2.5.1 Cognitive levels of learners

Many learners in the FET phase are currently not even at the formal operational stage as described by Piaget, a theorist who shaped the understanding of how a child's cognition changes in a predictable manner (Genovese 2003:128). Piaget believed that children have the ability to solve different types of problems; these problems are categorised into developmental sequences and it is these sequences that define the discrete stages of cognitive development (Genovese 2003:128-129). He identified four stages of cognitive development in children, with the formal operation stage being the last. This stage occurs from the ages of 11 years to adulthood. According to Piaget (1952), the formal operational stage is characterised by adult patterns of thought which involves logical, rational and abstract thinking.

Thus, during the formal stage learners are able to think logically about tangible situations; they are able to demonstrate, conserve, classify, and reverse (e.g. they can solve hands-on problem in logical forms; understand reversibility; and understand the laws of conservation) (Woolfolk 2007:29-31). At this stage learners develop the ability to reason by hypotheses based on logic; the learner has the ability to construct theories and make logical deductions about their consequences without having had any direct experience on the subject being dealt with (Simatwa 2010:369-370).

The slow cognitive developments of learners are contributory factors to the poor performance displayed by learners in Physical Sciences. As explained by Giannakopoulos and Buckley (2009:327-328), the cognitive skills (critical thinking, creativity and problem solving) of learners are of vital importance for learners to succeed as they are used in the creation and application of knowledge in real life situations. Physical Sciences lessons should be learner-centred, and allow for the active participation of learners. By developing lessons that are demonstrative and investigative the cognitive ability of learners are enhanced. Also the different views and ideas of each learner can be developed through sharing of ideas, allowing for constructivism. Through this type of lessons the convergent and divergent skills of learners are shared with each other, advancing into effective teaching and learning of Physical Sciences.

2.5.2 Teaching approaches

Physical Sciences as a subject requires an active learning strategy instead of a passive learning. Active learning involves students and teachers; education becomes a two-way process with both the teacher and the child learning from each other. Outcomes Based Education (OBE) placed tremendous emphasis on making learning a two-way process. But learner performance cannot solely depend on active learning, for those that have taught Physical Sciences and are aware of the content of the subject will agree that at times the educator is required to adopt a more passive strategy. However, the educator must be aware and deliver the information in a manner that is still able to capture the attention of the learner.

According to the cone of learning principal, active learning will take place when the learner is directly and actively involved in his/her learning process (Dale, 1969). During this process of active learning the learner not only takes in the information, but also actively engages with the learning material in some way. According to Woolfolk (2007:487), active teaching is teaching characterised by high levels of teacher explanation, together with demonstrations and student interaction.

The advantages of active learning are that a larger quantity of information is assimilated by learners at one time, interaction amongst learners is improved, learners' academic performance improves, it allows for stimulation of higher order thought as well as developing respect for the views and opinions of others (Unisa Study Guide for Physical Science SDPSCO-8 2007). Active learning requires not only a hands-on approach but it also needs for learners to have an inquiring mind and engage in the process of inquiry learning. Inquiry learning is defined as an approach in which the educator presents the learner with a rather puzzling situation and the learner then attempts to solve the problem by collecting data and then testing his/her conclusion (Woolfolk 2007: 351).

In many schools worldwide science education is practiced in a traditional age-old manner, that is, dictative, and authoritarian which has eliminated all forms of imagination. According to Christensen (1995), when this form of teaching approach was used in American schools, critical analysis of the results of learners indicated clearly that this system had failed. Thus, for the transformation of science learning, Christensen (1995) points out there must be change in the strategies and methods used in the classroom.

2.5.3 Teaching theories

Constructivism is one of the theories that had been neglected in the teaching of Physical Sciences. In their criticism on how science is taught in the classroom, Driel, Beijaard and Verloop (2000) argue that teachers usually present science as a rigid body of facts, rules to be memorised and practised by students and theories which they regard as absolute. Constructivists believe that emphasis should be on designing activities which provide active knowledge, instead of traditional knowledge transmission. Teachers are encouraged to investigate students' knowledge. In order to assign appropriate methods for teaching science, learners' misconceptions need to be identified (Kennedy 1998).

Constructivist theorists hold the view that teachers should deal not only with learners having high abilities or high motivation for science, but they should also look at the learners' cognitive and affective dimensions. By giving attention also to these dimensions, teachers will be shifting towards inquiry skills (Driel, Beijaard & Verloop 2000).

In general, constructivism puts emphasis on the ways that people create meaning of the world through a series of individual constructs (de Jong 2005). The constructivist teaching and learning models require learning that is hands-on, whereby students are actively involved in the learning process allowing them to build a better understanding; minds-on, allowing for learners to develop their cognitive processes, and encourage them to question the validity of the situation; and authentic, presenting learners with real-life problems that they may be faced with, in order to develop them to take a critical look in order to obtain the best possible solution (Christensen 1995).

Physical Sciences lessons can take on several forms. They include the practical lesson, the demonstration lesson, the theoretical lesson, supported by well-defined activities and the problem solving lesson (practice lesson). For optimum learner performance, the academic year of a learner should comprise of all the above type of lessons. This would allow learners to take a hands-on approach to their learning process as well as to think critically and creatively through the process of stimulation and communication with other learners thereby building on their existing knowledge through the process of constructivism.

Physical Sciences as a subject requires educators to have a good understanding of the subject and to be able to display foundation competence, practical competence and reflexive competence in the subject. According to Gough (2009: 183), there is a shortage of qualified science educators and this is expected to worsen over the years as very few students are taking up careers in science teaching. When there is inadequate preparation on the part of the teacher and a limited academic background, the result is poor teaching and in schools (Van der Westhuizen, Mosoge, Niewoudt & Steyn 2002:115). Research shows that although educators can sometimes master the theory of Physical Sciences, putting the theory into practice is a major problem. The pedagogical knowledge that teachers gain through their qualifications must be applied to their teaching of science, thereby narrowing the gap between theory and practice (Appleton 2003:2-4).

2.5.4 Societal factors

Parent involvement plays a pivotal role in educational issues. Schwartz (2001) reiterates the fact that schools communities and families should continually give support to the performance and achievement of their children. Schwartz (2001) explains that the role of the family is to develop a home atmosphere conducive to learning; participate in homework completion; and meet performance standards or anything, related to contributing to educational success (Adell 2002).

Learners tend to get frustrated and lose hope when they are unable to get the help they require at home and as a result their performance levels start to drop. However, one has to keep in mind that many black parents were victims of the apartheid regime and because of this their knowledge of Physical Sciences is poor, as a result affecting their role in assisting their children in the subject. Lemmer and Van Wyk

(2008:261) explain that parent involvement was regarded by the apartheid government as a means of financing schools. It was perceived as a means of paying school fees and fund-raising for the school. The actual involvement of parents in academic matters was not of top priority.

2.5.5 Learners' attitude

Investigating the attitude of learners towards science was the other factor that TIMSS (1999) explored. TIMSS reported that the generation of a positive attitude towards science, is an important and integral goal of science education. Many learners tend to avoid Physical Sciences because of their fear of the subject and a lack of self-confidence. This negative attitude can result learner underperformance and as a result being unable to get the required results for university entrance (Mullins 2005). The fear of Physical Sciences has resulted in a decrease in the number of learners taking the subject both at the secondary and tertiary level (Gough 2009: 183). During my experience as a Physical Sciences teacher at a public school in the Pinetown District in KwaZulu-Natal, a discouraged grade 8 pupil described Physical Sciences as "a killer subject". Okoye (2002:562) mentions that those learners who come from a higher socio-economic status family are more motivated to study and show a positive attitude towards their studies.

2.5.6 Socio-economic status

According to Baker and Jones (2005: 149), there is an association between low socio-economic status and poor performance in science in school. However, evidence has suggested that it is not the socio-economic status per se but factors associated with home resources and background experiences that affect the learners' performance in science. According to Saiduddin (2003: 22), factors such as unstable homes, drug abuse and teenage pregnancy contribute to poor performance among learners. Teenage pregnancy in South African schools is on the increase; consequently, the learner tends to drop out of school, resulting in an on-going cycle of poverty in the home, community, province and country.

2.5.7 Language problems

When learners learn in a language that is not of their mother tongue, learning then becomes more difficult. The Trends in Mathematics and Science Study (TIMSS) indicates a correlation between lower achievement levels in science and home language which is different to school language (Baker & Jones 2005: 149). When learners are required to learn content in a second language, they are faced with the problem of content literacy (Van der Poll & Van der Poll 2007). When learners have to use a language that they are not proficient in, then mastering content (both practical and theoretical) of a subject becomes very difficult (Van der Poll & Van der Poll 2007). This in turns affects the learners' performance in Physical Sciences because language plays an important role in the understanding of technical terms in a subject (Van der Poll & Van der Poll 2007).

For learners who are not taught in their mother tongue, the practical aspects of Physical Sciences become important. With the availability of the right resources educators are able to demonstrate experiments which can help these learners as well as those who are being taught in their mother tongue to gain a visual experience of the events that are taking place, and thereby improve their understanding.

2.5.8 Other factors

A number of other factors could contribute to the poor performance of learners in Physical Sciences. According to Okoye (2002:562), a number of factors (other than the motivating forces at home, scholastic ability and academic values) affect a learner's academic behaviour. One such factor is the social pressure placed on the learner by participants in the school settings.

Based on Van der Westhuizen et al., (2002:116) a lack of student discipline and commitment is a direct link to poor learner performance. Learners with poor behaviour (such as ignoring all instructions by the educator, failing to do and or complete work given, showing disrespect to the educator) tend to spend more time being reprimanded or outside the classroom. As a result the contact time of actual teaching and learning is diminished (Van der Westhuizen et al 2002:115-116).

Lack of school-based or home-based resources is also another factor that can affect poor performance at school level. In many public schools in South Africa, there is a lack of proper laboratory facilities; thus learning of Physical Sciences can become very difficult for learners. As a result Physical Sciences remains at a very theoretical level without any experiments to enhance the understanding and application of knowledge (Makgato & Mli 2006:254). Not all public schools in KwaZulu-Natal are equipped with sufficient resources (e.g. textbooks); as a result in some schools learners are not given a textbook to take home. Those who are of a higher socio-economic status are more likely to buy a textbook for themselves.

TIMSS (1999) documented detailed information about learners' home backgrounds. The study explored how learners spent their time out of school and also investigated their attitudes towards science. The TIMSS research report stated that students from homes with pricey educational resources have a tendency of performing well as compared to those that are coming from less advantaged backgrounds. The home resources that were referred to in the TIMSS (1999) report included: books in the home, educational study aids in the home study desk, dictionary and a computer.

2.5 THE TYPE OF EDUCATOR AND LEARNER REQUIRED FOR PHYSICAL SCIENCE

Teaching is a profession in which the educator should have confidence in what he/she is doing. An educator of Physical Sciences must possess an interest in his/her subject, commitment and dedication. He/she should be able to eradicate the fear that many learners have about the subject and encourage learners to look at the subject with confidence.

Very few students graduating with mathematics and science choose teaching as a career. As a result of this there is a shortage of mathematics and science educators and out of desperation educators of basic sciences such as natural sciences, life sciences could be forced to teach Physical Sciences. As a result, some schools do not even offer mathematics and Physical Sciences as school subjects (Makgato & Mji 2006:254).

The National Curriculum Statement for each learning area in the FET phase clearly stipulates the type of teacher and learner that is envisaged. It envisages teachers that are competent, dedicated, caring and qualified. The teacher must be able to fulfil the seven roles of an educator (i.e. educator as a leader and administrator; educator in a pastoral role, educator as a learning program developer, educator as a researcher scholar and life-long learner, educator as assessor, educator as a mediator of learning, and a learning area specialist). The National Curriculum Statement further envisages learners who will be imbued with values and acts in the best interest of society based on respect, democracy, equality, human dignity, and social justice as promoted in the Constitution.

Outcomes-Based education was introduced in 1997 to overcome curricular divisions. However, implementation prompted many reviews and finally it was decided from 2012 the two national Curriculum statements for Grades R-9 and Grades 10-12 respectively, would be combined into a single document, known as the National Curriculum Statement Grades R-12 (Department of Education 2011: 3-4). The National Curriculum Statement for Grades R-12 builds on the previous curriculum but also updates it and aims to provide clearer specification of what is to be taught and learnt on a term-by-term basis. This National Curriculum Statement Grades R-12 represents a policy statement for learning and teaching in South African schools and comprises of what is known as Curriculum and Assessment Policy Statements (CAPS) for all approved subjects (Department of Education 2011:3-4). CAPS is actually a single policy document that is present for every subject. It replaces Subject Statements, Learning programme Guidelines, and Subject Assessment Guidelines in grades R-12. Although CAPS will only be implemented in grade 12 in the academic year of 2014, the principles for Physical Sciences are the same as the National Curriculum Statement Grades 10-12 (general) for Physical Sciences (Department of Education 2011: 4-6). This study is based on the performance of grade 12 learners who were part of the National Curriculum Statement Grades 10-12.

It is important that teachers are able to understand and implement the NCS for the field of specialisation effectively and efficiently (Msila 2007). Thus, teachers need development along three dimensions simultaneously: content knowledge, teaching approaches and professional attitudes (Kriek & Grayson 2009:199). When educators possess a negative attitude, it reflects not only in their teaching but also in the learning environment. A stimulating environment awakens a learner to learn especially in science (Okoye 2002:562).

2.7 CONCLUDING REMARKS

This chapter provides the reader with a literature overview that provides the theoretical background for the study. I have discussed several factors that contribute to the poor performance in Physical Sciences. In the following chapter, the research design, the data collection methods and procedures (i.e. the collection instruments used), population sampling techniques, location and demographics are described. Also included are the issues around ethical considerations and informed consent.

CHAPTER 3
RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

This chapter presents the research design of the study. The study employs both the quantitative and qualitative research methods with a self-designed structured questionnaire, interviews and a non-standardised test for learners. A discussion of the research design, selection and description of sites, the data collection methods and procedures (i.e. the collection instruments used), population and sampling techniques is included.

3.2 RESEARCH METHODOLGY

The mixed method research design is used in this study. It combines both quantitative and qualitative methods. This method allows for results to be shown quantitatively and explains why they were obtained qualitatively (McMillan & Schumacher 2006:27-28). The rationale for the mixed method is that it is more flexible and enables the researcher to delve into a deeper understanding of the learners' views, beliefs, ideas, fears and thoughts about Physical Sciences. A non-standardised test for learners was also used to conduct this study. The incidence, distribution and frequency for the larger population were described; by using only a small sample of the participants from the population, (McMillan & Schumacher 2006:223) a deeper understanding of factors that leads to poor performance in Physical Sciences was sought.

Interviews were used to collect data. Bogdan and Biklen (1992:96) explain that the interview is "a purposeful conversation, usually between two people but sometimes involving more, that is directed by one in order to get information from the other". Interviews have both advantages and disadvantages. The advantage for using interviews is that the interviewer, can adapt the questions (if necessary) during the interview process (McMillan & Schumacher 2006:203-206). Also signs of non-verbal communication can be observed and taken into account. Interviews allow for the interviewer to probe and get a clearer response to questions; and the questions for interviews can be structured, semi-structured or unstructured (McMillan & Schumacher 2006:203-206).

3.3 AREA OF STUDY

This study was conducted in two under-performing secondary schools in the Pinetown District, KwaZulu-Natal. The schools were selected on the basis of convenience and purposeful sampling (McMillan & Schumacher 2006). Patton (1990:52) mentions that "the power of purposeful sampling lies in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of evaluation". Both schools were classified as "under-performing schools: they had both underperformed in Physical Sciences Senior Certificate examination for three years. Their National Senior Certificate results have been below 60% between 2008 and 2010.These two schools were information rich sites for the study. Convenient sampling applied as the two schools are located in the Pinetown District and they were therefore accessible to the researcher and enabled the researcher to distribute the questionnaires efficiently. This meant that the two schools were information rich for the purpose of this research project.

3.4 THE RESPONDENTS

3.4.1 Population

The population included all grade 12 Physical Sciences learners at the two schools. The aim of selecting grade 12 learners, Physical Sciences teachers and specialists housed in the Department of Education was to better understand both the degree and the nature of challenges they are faced with in the learning and teaching of Physical Sciences as a subject.

3.4.2 Sampling

A sample can be defined as a small proportion of the total set of objects, individuals or events which together make up the subject of our study (Seaberg 1998:240). A purposeful sampling technique was used to select Physical Sciences learners in the two schools (McMillan & Schumacher 2006). The sample of the study consisted of a total of 100 grade 12 Physical Sciences learners; three Grade 12 Physical Sciences teachers; two Natural Sciences Heads of Department and one government Physical Sciences subject specialist.

The reason for including grade 12 Physical Sciences learners was that this sample needed to be representative of the relevant population. The selection of all Grade 12 Physical Sciences learners was aimed at selecting a heterogeneous sample, which had a variety in terms of socio-economic standing, language affiliation, age and gender. The Physical Sciences teachers and Physical Sciences subject specialists were also included because of the expert knowledge in the subject.

3.5 DATA COLLECTION

Data collection instruments used for this study were interviews, questionnaires, non-standardised test for learners and observations.

3.5.1 Questionnaires

For this study questionnaires were of great value for a variety of reasons. They were economical, the questions were standardized and uniform procedures were used. Three sets of questionnaires were distributed to two schools. Teachers were expected to complete two sets whereas learners were expected to complete only one. The questionnaire for learners comprised of seven open-ended questions. The questions ranged from the challenges that learners experienced with the subject, the activities that learners engage with and the role that subjects such as mathematics play in ensuring that they acquire problem-solving skills.

The questionnaire for the teachers was divided into four sections and comprised of 31 questions. Section A (6 questions) was focussed on the biographical data of the respondent. Section B (11 questions) investigated the attitude of teachers towards teaching Physical Sciences. Section C (14 questions) looked into the activities that teachers could do to enhance the teaching of Physical Sciences. Section D provided a space for teachers to add any additional information.

Initially, the questionnaire was taken to ten grade 12 Physical Sciences learners to complete. The initial sample group acted as a pilot study to identify ambiguities in the questionnaire. After piloting, the questionnaire was refined which led the researcher to edit and amend some sections for clarity.

The questionnaire was completed anonymously and participants were allowed an hour to complete it. The covering letter, which was part of the questionnaire, explained the purpose of the research and gave assurance of confidentiality. I introduced myself to participants and also explained the instructions and some of the terminology used in the questionnaire. Participants were encouraged to ask questions.

3.5.2 Observations

Neville, Willis and Edwards (1994:81) explain that "what is observed is the researcher's version of what is there". While gathering data through questionnaires, observations such as hesitation in answering or facial expressions reflecting various unspoken emotions, fears, aspirations and hopes were noted. Observation was also made in multiple but disparate settings to observe the everyday actions and reactions of the participants in their learning environment. I also observed the physical resources at the two schools. Observation allows for the natural behaviour of subjects in the study and is relatively unobtrusive (McMillan & Schumacher 2006). I also took time to observe learners behaviour during the teaching time; the focus was placed on their attention span during the lesson. With this in mind, observation was conducted in the two groups taught by the two teachers in the two schools where focus was placed on how Physical Sciences was taught at the schools. I observed resources available at the two schools. Permission was sought from both the Department of Education and the principals to do those observations. During the process of observation, I had to consciously remain aware of my own biases and preconceptions, and how they may impact on what I was trying to observe and understand (Maykut & Morehouse 1994: 18).

3.5.3 Non-Standardised test for learners

A non-standardised test was also used to determine if learners in grade 12 had a common foundation of basic concepts of Physical Sciences learned in grades 10 and 11. The test also aimed at assessing learners' level of competency in some of the most fundamental concepts of Physical Sciences as a subject.

The test comprised six questions. These questions were based on basic concepts that a science learner, especially at grade 12, should have been familiar with. Question 1 tested laboratory safety measures; question 2 tested the level of the knowledge of laboratory apparatus; question 3 was about the knowledge about commonly names for basic laboratory chemical, question 4 dealt with conversion; question 5 dealt with balancing equations; and question 6 dealt with basic knowledge of physics concepts.

3.5.4 Interviews

Silverman (1993) explains that interviews offer an apparently 'deeper' picture than the variable-based correlations of quantitative studies. An interview is a data collection method in which the interviewer asks questions of the interviewee or participant while aiming at entering the inner world of the respondent and gaining an understanding of that person's perspectives. In this study, I chose face-to-face semi-structured interviews to collect rich data from participants (Neuman 1997).

A semi-structured interview which is flexible, allowing new questions to be brought up during the interview as a result of what the interviewee says was used in this research. The interviewer in a semi-structured interview generally has a framework of themes to be explored and the interview progress in a way which tackles the identified themes. Silverman (1993) maintains that a semi-structured interview involves a set of open-ended questions that allow for spontaneous and in-depth responses (Silverman 1993). The use of semi-structured interviews also enabled teachers to describe their experiences and attitudes towards teaching of Physical Sciences in grade 12 in greater detail. This method enabled the researcher to use probes (Rubin & Rubin 2005).

These interviews conducted with the teachers granted me the opportunity to explore the feelings and views of grade 12 Physical Sciences teachers about the teaching of Physical Sciences including challenges and difficulties they face. The literature dealt with in the previous chapter, which shed light on factors affecting Physical Sciences learner performance, helped me prepare appropriate questions for the purpose of the study.

Physical Sciences teachers were asked to participate in the interview after they were given information about the study. Probes were used by the researcher to provide a better understanding and obtain deeper information about challenges that Physical Sciences learners and teachers experienced. Probe questions were not included in the interview schedule. In the interview schedule teachers were asked about challenges that Physical Sciences teachers experience. These questions led the research project to a clearer understanding of the issues raised in the research questions. The latter dealt firstly with the methodological, pedagogical and general experiences teachers have when teaching Physical Sciences (see appendix B4). Interviews with teachers were carried over a period of two weeks. Teachers were invited for interviews and they were conducted with each teacher in their free time. Teachers were assured that their confidentiality would be kept through the study. I used a tape recorder with the interviewees' permission during the sessions. Each interview lasted from 30 to 60 minutes.

3.6 DATA ANALYSIS PROCEDURE

Data analysis is a widely used qualitative research technique. Barbie and Mouton (2001:563) explains that "[t]he worth of all scientific findings depends heavily on the manner in which the data was collected and analysed". Gardner (2009:260) explains that data analysis refers to the process of inspecting, cleaning, transforming and modelling data with the goal of highlighting useful information, suggesting conclusions and supporting decision-making.

The questionnaires were analysed using the Statistical Analysis System version 9.2 statistical package. I analysed the open-ended comments and the findings are presented in Chapter Four. Gardner (2009) divides data analysis into descriptive statistics, exploratory and confirmatory data analysis. While exploratory data analysis focuses on discovering new features in the data, confirmatory places emphasis on confirming or falsifying existing hypotheses.

3.6.1 Data Analysis Strategy

The analysis strategy was based on the research question which states: *What are the contributory factors for the poor performance of learners doing Physical Sciences in the FET phase in public schools in the Pinetown District, KwaZulu-Natal?*

The following areas of learner performance in Physical Sciences in grade 12 were identified in the questionnaires, interviews and non-standardised test:

(i) Questionnaires and interviews

- The challenges and experiences that the educators have with regard to teaching of Physical Sciences (Teacher questionnaire 1 and 2);
- The resources in the schools (Teacher Questionnaire 3, Section A; Interviews for teachers);
- The impact of the LoLT on the teaching and learning of Physical Sciences (Teacher questionnaire, Section B; Interviews for teachers).

(ii) Non-standardised test

- Learner resources; the reasons why they chose Physical Sciences; their socio-economic status; the impact of mathematics and Mathematical Literacy on the acquisition of their science skills;
- The impact of their home language on learning of Physical Sciences;
- Basic knowledge of scientific concepts learned in grade 10-12.

The analysis included one-way frequency tables on the biographical attributes of the sampled respondents and enabled the researcher to have a better background knowledge of the sample. Composite frequency tables were provided to provide detailed information of home language distribution; socio-economic status of learners; resource allocation of the schools, and challenges facing grade 12 Physical Sciences teachers.

3.7 RELIABILITY AND VALIDITY

Creswell (1994) explains that quality criteria such as trustworthiness and authenticity should be established in qualitative research. Lincoln and Guba (1989:290) contend that trustworthiness of qualitative research identifies four primary components that are relevant to such an inquiry: truth value, applicability, consistency and neutrality. Holton and Burnett (1997) argue that measures that are used to measure reliability and validity are valid if they measure what they are supposed to. In this study, the questionnaire and interviews were regarded as valid and elicited accurate information. They provided a real measure of:

- Challenges facing grade 12 Physical Sciences teachers and learners;
- Reasons why learners perform poorly in Physical Sciences.

3.8 ETHICAL ISSUES

Ethical and legal practices are imperative in any research that is undertaken. It is important to adhere to universal ethics such as honesty and maintaining respect for the rights of individuals (Welman, Kruger and Mitchell 2010:181).

Prior to engaging in the research, a letter was sent to the KwaZulu-Natal Department of Education and the schools involved for informed consent. Informed consent is achieved by providing subjects with an explanation of the research (McMillan & Schumacher 2006:143). Before I moved into the field, consent was obtained from the relevant Education Department and the schools. School principals were contacted and a preliminary meeting was held with them to discuss how and when the research was to be conducted. All respondents and the location of the research sites remained anonymous and the privacy and confidentiality of all subjects in this study were protected.

3.9 LIMITATIONS OF THE STUDY

Limitations of this study can be listed as follows:

- Since this research study was conducted in two schools of the Pinetown District and has been chosen purposefully, findings cannot be generalized to all of the schools in the KwaZulu-Natal province;
- The study was only applicable to grade 12 Physical Sciences learners and teachers;
- Due to reason of time limitations, only 100 learners, three physical science teachers and a subject specialist took part in the research study about contributory factors of low performance of learners in Physical Sciences.

3.10 CONCLUDING REMARKS

In this chapter, I have explained and described the research design, selection of the research approach, site selection, sampling, data gathering and data analysis strategies. Ethical issues were also carefully discussed and strict rules governing this aspect of research were observed throughout the whole process of the study. The results of this research are presented in the next chapter.

CHAPTER 4
PRESENTATION OF FINDINGS

4.1 INTRODUCTION

In this chapter all data collected were analysed to understand the phenomenon of poor performance in Physical Sciences in selected schools in the Pinetown District. Data collection tools included learner interview questionnaires, teacher interviews, observation and a non-standardised test. These tools are supplied in Annexure A, B, C and D. A mixed method approach was used during this investigation. The finding of this research were categorised according to the initial aim of the research. Although categories overlapped to some extent, in summary they provided a comprehensive report of the results based on the quantitative and qualitative research.

4.2 RESULTS AND ANALYSIS

In the following section I present the findings.

4.2.1 Learner dynamics

A sample population of 100 learners who were registered for grade 12 in the two schools in the academic year of 2013 in the Pinetown District was taken. The number represents a reasonable sample for learners doing Physical Sciences.

4.2.1.1 Gender and age group

Table 4.1: Percentage of male and female learners doing Physical Sciences

Male	Female	Total (%)
36	64	100

According to the table, 64% of learners were female and 36% male, suggesting that more females were planning to take up careers in the science field.

Table 4.2: The age group of learners from School A and School B

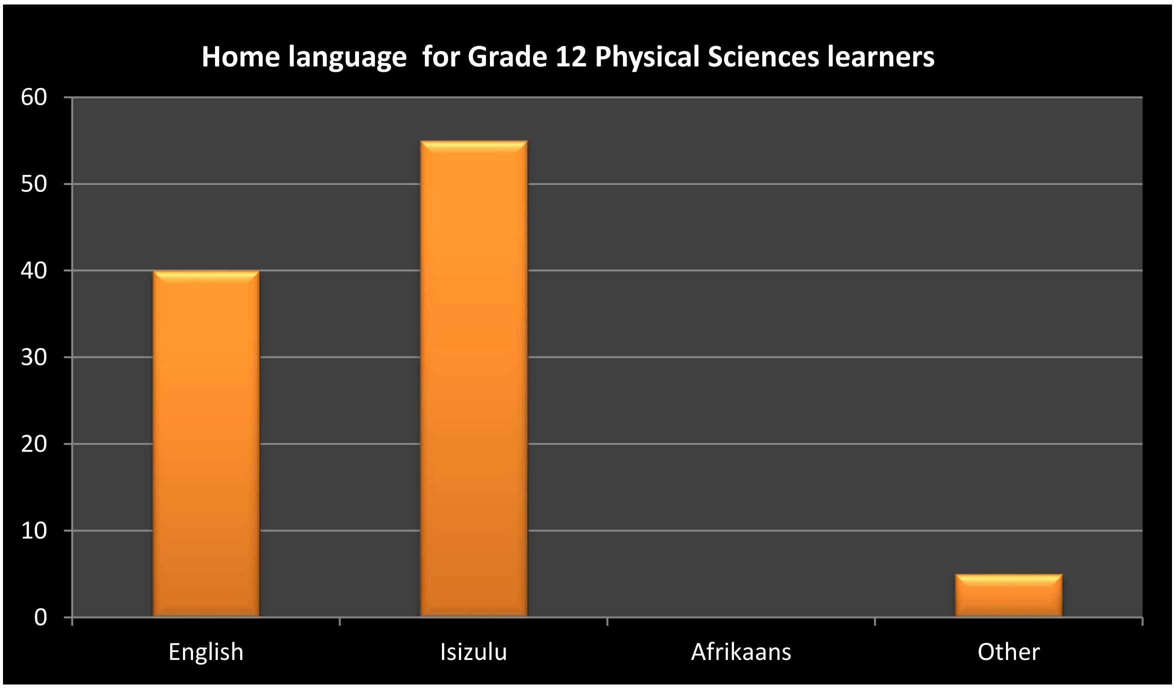
	16-18 years	19-21 years
School A	45	5
School B	50	0
Total (%)	95	5

The majority (95%) of the learners fell into the age group of sixteen to eighteen years of age, and only 5% in the age group of nineteen to twenty-one years of age. The latter suggests that some learners may have repeated a grade through their schooling career or started schooling late.

4.2.1.2 Home language

The LoLT in both schools was English. For many learners English is not their mother tongue. Figure 4.1 indicates the different languages that were identified and the percentage of learners whose home language was not the same as that of their school.

Figure 4.1: Home language distribution for Grade 12 Physical Sciences learners



For many learners English was not their mother tongue. Only 40% of learners' home language corresponded to the LoLT. Fifty-five (55) percent of learners who are predominantly Zulu-speakers are taught in English, which was their L2. The LoLT plays a vital role to understanding content of knowledge.

Based on the responses to the learner questionnaire, question 10 (Annexure A), the majority of learners (56%) especially those whose home language differed from the LoLT felt that if Physical Sciences was taught in their home language, their performance would improve due to a better understanding of the subject. Learners said that being taught in mother tongue facilitates understanding and the "why's, when and how and what" would be easier for them to understand. The interpretation of questions becomes difficult when it is given in L2, thus making explaining difficult. Learner confidence is based on their ability to understand; when learners understand, they have more confidence and take more interest in the subject.

The following question was posed to grade 12 Physical Sciences learners: "If Physical Sciences were taught to you in your home language, would you have a better understanding of the subject and would your performance improve?" These are some of their responses:

> *I believe that I would have a better understanding if it [Physical Sciences] was taught in my home language.*
>
> *Yes, I think it [teaching in vernacular] would help us to improve because I understand my own language better than I understand the language we use at school.*
>
> *Yes, I would have a better understanding and my performance would increase drastically.*
>
> *Yes. Because there are words in physics which I don't understand so if physics were taught in isiZulu I think I would be doing good in the subject because it's my home language.*
> *Yes, English is not home language for some of us. If physics were taught in isiZulu I could get an "A" symbol.*

Through observations of learners it was clear that for some learners whose home language differed from the medium of instruction, their ability to communicate with the teacher was not as clear as those whose home language matched the medium of instruction. Their ability to express themselves was poor and very often required the assistance of a friend to translate what the teacher was saying.

More than 50% of learners believed that activities such as peer tutoring provided them with a tremendous amount of help as they were able to converse in their home language. Very often the meaning of words in English was difficult for them to understand during lessons, and this hindered their understanding of the work.

Learners' responded to the question: "Are extra lessons in Physical Sciences outside school an affordable option for you?".They also mentioned if they prefer to converse in their mother tongue during peer tutoring. Responses from learners were as follows:

Well I think so, because I have tried that last year. Our teacher spoke Zulu and so it make it easier.

Yes, a lot, because my classmate explain in our home language. I understand the subject better and able to respond to him/her. But my teacher I find it hard to even answer sometimes in proper English so it will be much better if it's taught in my home language"
I think they should make the theory/textbook be written in isiZulu like it is written in Afrikaans...

Based on the responses from teachers and the subject specialist, language also affect the reading and understanding of learners, particularly when it comes to reading textbooks and examination questions. From past experience some teachers noted that learners complained of not understanding what the question required. Also it has been noted in the National Diagnostic Report on Learner Performance 2012, many learners had problems with interpretation of questions in Physical Sciences (Department of Education 2012:165-198). A plausible reason is the language problem. The subject specialist for Physical Sciences as well as a teacher agreed that language affected the performance of learners and their responses were as follows:

It may affect the reading and understanding of material from the textbook (Subject specialist).
Yes, many have complained they did not understand the question, like what is it asking for (Educator).

Based on the responses to the learner questionnaire, question 10 (Annexure A), over 50% of learners especially those whose home language differed from their medium of instruction, felt that if Physical Sciences was taught in their home language, performance levels would improve greatly, due to a better understanding of the subject content.

Figure 4.2: Analysis of questions under specific concepts

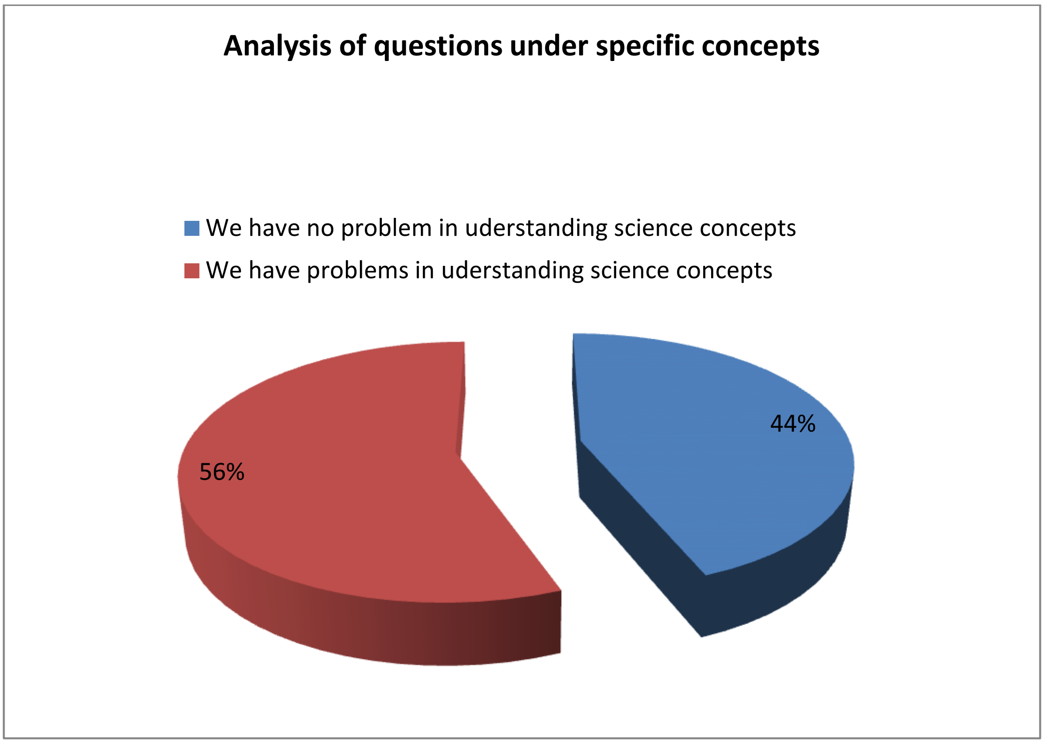


Figure 4.2 indicates that 56% of learners have a problem with the understanding of concepts in Physical Sciences. One has to remember that only 40% of learners in the two schools were taught in their home language (See Figure 4.1). Those learners, whose home language corresponds to the LoLT, firm believed that the above link plays a very important role as understanding the lesson was vital to succeed in a subject that is deemed "difficult" by society in general. However, to improve on their understanding, many learners attended additional lessons outside of school. But this luxury of additional classes was not affordable to every child.

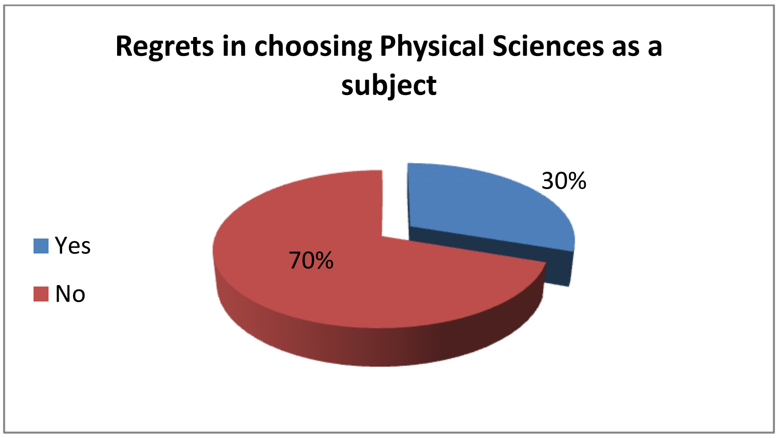
4.2.1.3 Why learners chose Physical Sciences

When learners were asked why they had chosen Physical Sciences, 73% planned to pursue a career in science, with a small minority (2%) either being forced to by parents, or felt that it would be interesting. Figure 4.3 reflects the results.

Figure 4.3: Reasons why learners chose Physical Sciences

Although so many learners felt that they would take up a career in science, clearly they were not fully aware of the content of Physical Sciences as well as the demands and dedication it required. From the 73% of learners who chose Physical Sciences, some of them had regrets (See Figure 4.4).

Figure 4.4: Percentage of learners who regret choosing Physical Sciences as a subject



Although more than 70% of learners had no regrets in choosing the subject and made a concerted effort to succeed, the pass percentage remains a matter of concern. The remaining 30% of learners clearly had no interest in the subject but had to continue with the subject for reasons mentioned in Figure 4.3. In the South African education system every grade 12 learner has the right to know the requirements to pass the grade at the end of the academic year. Observations suggested those who regret choosing the subject were discouraged and thus likely to fail the subject at the end of the year.

4.2.1.4 Socio-economic status of learners

The socio-economic status of learners from the schools under investigation was grouped into three categories: those from high income homes, average income homes and below average income homes. High income homes in this study refer to those which have surplus funds available at the end of each month. Average income homes refers to homes that are just able to meet their demands, with no extra money left over for luxuries, such as additional lessons, textbooks, extra travel and fancy accessories. Below average income homes are those that can hardly meet the financial requirements of daily life and rely on child support grants and foster care grants. Most of the learners are coming from average income homes (see Figure 4.5).

Figure 4.5: Socio-economic-status of learners

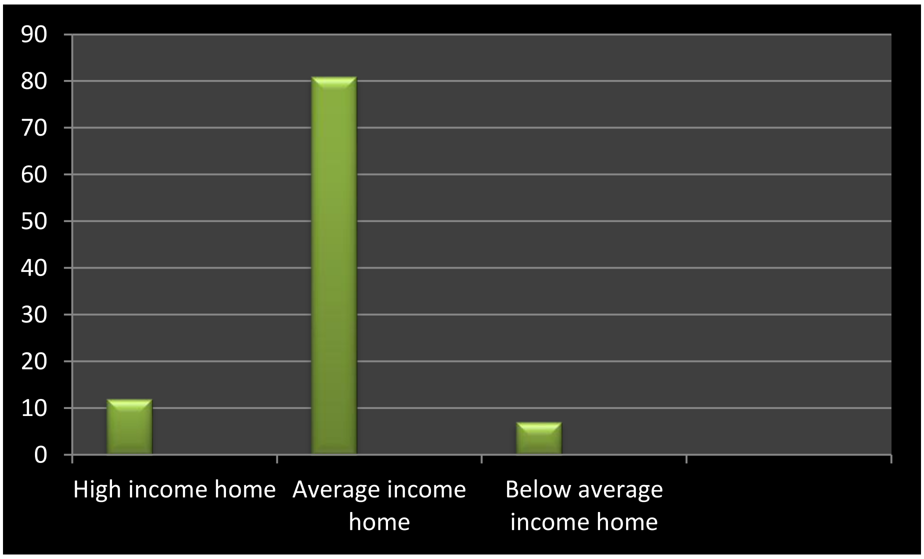
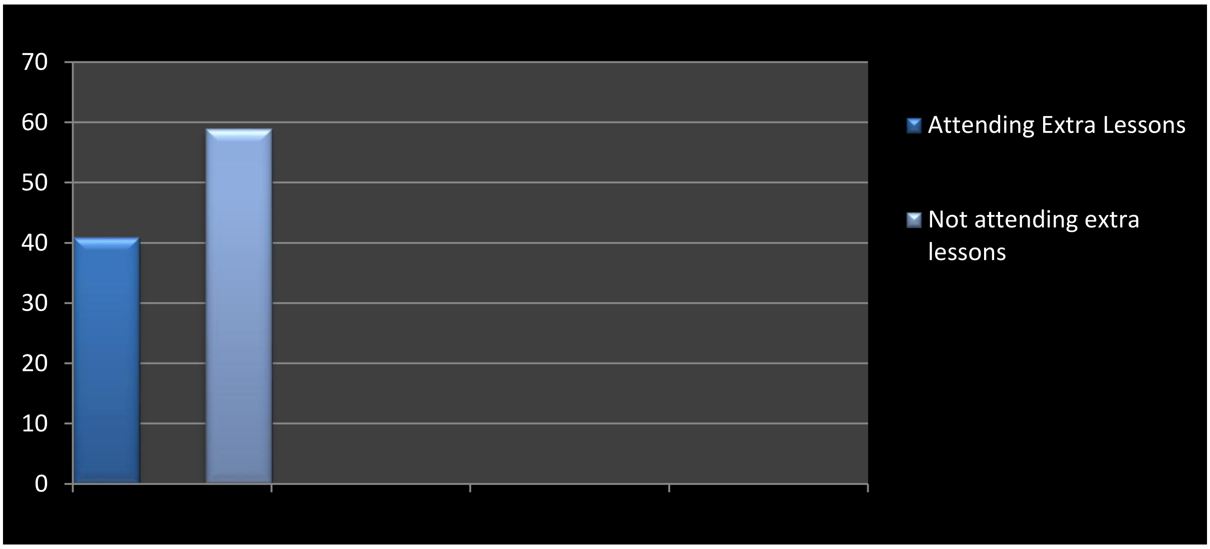


Figure 4.5 indicates that 81% of learners were from average income homes, while 12% were from high income homes and a very small 7% come from below average homes. The family background of a learner plays a very important role in the learner's learning process, family background includes factors such as socio-economic status, two-parent versus single parent household, divorce, family size and neighbourhood (Majoribanks 1996). The home environment of a learner influences his/her performance at school. Barry (2005:7) mentions that a low socio-economic status negatively affects academic achievement because it prevents the access to vital resources. International research has shown that learners whose parents have better jobs and higher levels of educational attainment are able to expose their children to more educational and cultural resources at home; as a result these learners perform better than their counterparts at school (Udida et al 2012).

More than 80% of learners from the two schools were from an average income home. This implied that not every child may have the advantage of attending extra lessons outside school or buying textbooks and study guides. The views of the teachers and subject specialist was that those learners who were from higher income homes tended to perform at an above average level, as some of them attended private lessons and got the individual attention they needed to help improve their performance. They also tended to have access to several text books and study guides as well as visual media.

The socio-economic status of the learners in the two schools affected them also in terms of enrolment for additional Physical Sciences classes. See Figure 4.6: Percentage of learners who attend additional lessons in Physical Sciences outside school, for more information.

Figure 4.6: Learners who attend additional lessons in Physical Sciences outside school



According to the results obtained above, clearly not every child attends extra lessons in Physical Sciences; the poor family background of learners is thus a factor which contributes to underperformance. Based on the responses of learners from the interviews, many learners pointed out that extra lessons were not an affordable option to them for the following reasons: very large families and working parents. Some families comprised orphans, pensioners and in most cases these families did not afford to enrol learners for extra classes. Furthermore, extra science classes occurred in places that were far from their homes and transportation costs were high. This is illustrated by the following:

> *There is only one parent working in the family and it becomes very costly.*
> *My mother is a cleaner so she has to support me and my two smaller brothers.*
> *My parents cannot afford it, they've already spent much since I started matric.*
> *I live with my pensioner grandmother who supports a family of 8 with the little money we receive.*

I have never tried them before; I always find them expensive because my mother is a pensioner.

They are very costly and also transport to the venue where Physical Sciences classes are taking place is costly. It's R150 an hour so it's hard to afford.

A further constraint that was identified was those learners who can afford to attend extra lessons outside school did not have sufficient time as they attend extra lessons in several subjects. A learner had the following to say:

I won't have time to attend extra lessons on weekends as we also have extra lessons on weekends at school for maths and life sciences.

Thus, poor time management on the part of learners can lead to poor results as learners fail to spend that additional focus on Physical Sciences. My observation was that many learners in these schools have over the years developed a negative attitude towards the subject; they believe that if they could understand the subject at school, extra lessons would not help. Not only did learners possess a negative attitude but have a very low self-esteem of their capabilities. Some learners are not willing to allow themselves the opportunity to try and understand. According to Maslow's Hierarchy, it is only when these lower level of needs or deficiency needs are met and satisfied does motivation for them decrease and the higher level needs of intellectual development and self-actualisation are met (Woolfolk 2007: 375). Responses of learners indicated that many have yet to fulfil their lower level need of self-esteem, before achieving intellectual development.

Other reasons for not attending Physical Sciences extra classes were that extra lessons do not give them that individual attention they required; the classes were also big. Where individual lessons are available, they are very expensive. Supporting statements for the above findings were based on the responses from interviews:

A large number of students attend extra lessons which makes it very hard to understand.
Too little time is spent on other sections and I don't get the individual attention I need.

Statements cited above demonstrate various views with regards to attending Physical Sciences extra classes.

4.2.1.5 Mathematics versus Mathematical Literacy

In School A more than 50% of learners do Mathematical Literacy, as opposed to School B where no Physical Sciences learner does Mathematical Literacy. Mathematical Literacy is defined as a subject that provides learners with an awareness and understanding of the role that mathematics plays in the modern world (Department of Education 2003:9). It is a subject driven by life-related applications of mathematics and enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems (Department of Education 2003:9).

In School A, many learners complained of being unable to solve the mathematical part of Physical Sciences especially when it came to using functions, such as trigonometric functions, quadratic equations and subjects of the formula. Some learners felt that Mathematical Literacy was like Business Studies: very theoretical with few calculations and no calculations as complex as those in mathematics. One of the learners remarked:

Mathematical Literacy it's more like Business Studies it does not involve the hard calculations that we do in Physical Sciences.

Based on the response from a Physical Sciences subject specialist, many mathematical skills are needed in Physical Sciences and these skills are not taught in Mathematical Literacy. In the 9th question of the interview, teachers were asked: "Does the performance level of a grade 12 learner in Physical Sciences differ for a learner who does Mathematics compared with learners who do Mathematical Literacy?" One teacher remarked:

> *Yes, definitely. A lot of mathematical skills are needed in Physical Sciences e.g. trigonometric ratios, and differential calculus. These sections are not done in Maths Literacy.*

Mathematics is based on observing patterns, with rigorous logical thinking. This leads to theories of abstract relations (Department of Education 2003:9). The majority of learners in School B felt that by doing Mathematics, the calculation in Physical Sciences was a lot easier, as they knew and understood what to do and when to do it because they had learnt it in Mathematics.

More than 50% of Physical Sciences learners agree that mathematics play a major role in helping them do Physical Sciences sums. The following quotes give an overview of what learners think about Mathematics Literacy and pure mathematics.

> *Yes, pure maths helps me a lot especially with simultaneous equations.*
>
> *The principles of mathematics can be applied to Physical Sciences when solving problems, especially trigonometry. I know how to tackle the problem.*
> *Most of the equations used in Maths are also used in physics, like the trigonometry and quadratic equation.*
> *Yes, because there are methods of solving equations in physics that are similar to maths.*
> *Yes – it is a great benefit because I have noticed that there are a lot of maths work included in physics e.g. finding x, etc.*
> *Physical Sciences problems involve maths therefore it makes it easier if you know the routine to answering it.*

The National Diagnostic Report on Learner Performance 2012 for Physical Sciences (Department of Education 2012: 165-198), concurs with the observation above by pointing out that many Physical Sciences learners are not mathematically skilled in terms of, for example, handling calculators, and/or the use of trigonometric functions which ultimately contribute to poor learner performance. The Report suggests that learners who do Physical Sciences must be encouraged to take Mathematics in order to acquire necessary mathematical skills needed in Physical Sciences.

4.2.2 Learner non-standardised test

The learner test (Annexure D) tried to determine the broad basic knowledge of the learners. The activity was based on the fundamental aspects or basic building blocks of Physical Sciences. Concepts, such as writing of chemical formulae, balancing chemical equations, chemical names and the common name of chemical substances, identifying laboratory apparatus, as well as basic rules when working in a laboratory, are taught to learners in grade 10. These are prerequisites a learner needs to have in order to succeed in Physical Sciences. The questions would be regarded as common sense and require learners to put the basic concepts of Physical Sciences which they have learnt from grade 10 into practice. This activity not only tests learners' knowledge but also their broad knowledge on safety (see Table 4.3).

Table 4.3: The distribution of scores by learners in each school for the activity (Annexure D).

Score (%)	School A (frequency)	School B (frequency)
0-5	0	0
10	1	1
15	1	0
20	1	2
25	2	2
30	4	5
35	3	6
40	5	3

45	4	7
50	2	3
55	10	6
60	4	3
65	3	7
70	3	1
75	6	2
80	1	0
85	0	1
90	0	1
95-100	0	0
Number of learners (n)	50	50

The mean which is basically the arithmetic average of all scores (McMillan & Schumacher 2006:159) in two schools is calculated below:

Mean For School A:

XA = ΣX / n

= 2524/50

= 50.5

Mean For School B:

XB = ΣX / n

= 2404/50

= 48.1

The above calculations are descriptive statistics that summarises the data gathered from the sample population. The performance levels of the learners per school are narrowed down to a single number. Based on the above results almost 50% of grade 12 Physical Sciences learners are familiar with the basic concepts of Physical Sciences taught in grade 10. The difference between the average scores for the two schools is fundamentally insignificant. The median which refers to that point that divides the rank-ordered distribution into halves that contain an equal number of scores (McMillan & Schumacher 2006:159), was calculated. Table 4.4 shows the median for each school based on the test results.

Table 4.4: The median for each school based on the test results (Annexure D)

Median for School A	Median for School B
Mdn = 55	Mdn = 45

The medians for both School A and School B were below 60% thus indicating the central tendency was still on a poor performance level at both schools. The mode, which refers to the score that appears most frequently in the distribution (McMillan & Schumacher 2006:160), was calculated.

Table 4.5: The mode for each school based on the Activity Results (Annexure D)

Mode for School A	Mode for School B
Mode = 55	Mdn = 45 and 65 (Bimodal)

Based on the descriptive statistics above, it was clear that the learners of the two schools were struggling with Physical Sciences. Learners were unable to identify with basic grade content knowledge. The mean for School A was 50.1 while School B was significantly lower than School A at 48.1.

The pass rate at 30% level in both schools would be 90% (from Table 4.1), when based on a grade 10 competency test at grade 12 level. At a 40% pass, the performance level of the schools is 76% and 68% for Schools A and B respectively.

Based on the results from the non-standardised test, it was noted that in both schools more than 80% of learners' were unable to identify with basic laboratory equipment (Annexure D, Question Two) such as tripod stands, measuring cylinders and conical flasks. Based on the responses from question 6 of the activity, which tests the learners' formal operational thinking ability, most learners did not answer this question or got it wrong. Fejfar (2007) argues that Piaget, in his work, was of the firm belief that a more abstract and difficult type of thinking known as the formal operations or hypo-deductive thought existed and would be developed fully between the ages of eleven to fifteen years. Formal operations are the last of the major stages of cognitive growth (Simatwa 2010:367). Thus, many learners in the above two schools have not reached this stage as yet (although they have passed the age of fifteen); they are most likely still at the concrete operations stage of development. Individuals in concrete operations cannot plan for the future, cannot compare and contrast possible alternative future courses of action nor choose a future which is logically superior (Fejfar 2007). In the activity many learners were unable to compare and contrast the two paths given and see that path B would have been the better of the two. Thus, learners identified several factors that hinder their performance in Physical Sciences.

4.2.3 Resources

In the following section, findings about the effect of resource provisioning will be described.

4.2.3.1 Lack of textbooks

Resources provisioning are an essential component of any working environment. School A and School B experienced problems with regards to the provision of text books. Based on the learner responses on question 8 (Annexure C), which requires them to indicate whether they do have a Physical Sciences textbook to take home daily, 62 learners did not possess a text book that they could take home. According to my observation as a science teacher, only worksheets were provided. Evidence of this was given by learners in their response to question two (Annexure A) which states: “Does your school provide you with the required textbooks or did you have to buy your own?” Learners’ responses were as follows:

> *You have to buy your own; we only get worksheet.*
> *The school only provides worksheets sometimes.*

The few text books available were used in class but learners had to share either one between two and one between three, depending on the attendance of the class for the day. However, for many learners the worksheets did not do justice in helping them. In School A, learners were requested to purchase a study guide for Physical Sciences. Most learners were unable to afford a study guide as it was not within the budgets of the parents. They also indicated that Physical Sciences was not the only subject that required a study guide. One learner remarked:

> *The school makes us buy a text book for each and every subject that needs a book and for physics as it is I had to pay R130.00 for a book which I could hardly afford. It's really hard because it's not the only subject that needs such attention.*

School B suffered the same fate in terms of text book availability. Learners were not provided with text books by the school due to insufficient stock; so many learners took it upon themselves to purchase a study guide. However, it was only those who could afford to do so. One learner said:

> *We buy our own text books; however, not all my friends could afford to do so.*

Based from the poor background that learners were coming from, not every child was able to purchase the study guide for Physical Sciences, which costs approximately R80.

4.2.3.2 Laboratory equipment

Physical Sciences is a subject that requires hands-on work as well. This subject consists not only of a theoretical component but also a practical component. According to my observation, School A, did not have a well-equipped laboratory; however, the basic needs such as running water, fire extinguishers and charts were evident. The laboratory rules were clearly displayed on the walls of the laboratory.

Practical work is of great importance; based on the responses from learners in School A, the few practicals that they conduct, not only captures their attention in class but also improves their understanding of the section being taught. Learners tend to find the subject more enjoyable when practical lessons are done. Most learners responded that practical lessons forced them to undertake their own research and take the time to read and improve their understanding. In Question 3 (Annexure A) learners were expected to respond to whether they engage in practical work and if so, why do they think such an engagement is important. They responded as follows:

> *Yes, I do engage in practical activities and they do help me understand the most fundamental concepts in Physical Sciences.*
> *Yes, it does improve my understanding to the subject.*
> *Yes, and yes it does help us understand better, lot of theory is put in, we get to understand the laws being used...*
> *Yes, I do participate in practical activities and it does help to improve my understanding of the subject; especially when the practicals activities require you to be in a group.*
> *Yes, we do and honestly it does help and it makes the section even more interesting.*
> *Yes, we do practical activities which make it easy for us learners because we tend to understand things better when we visualise them. We also remember it during examination.*
> *Yes, it does because it makes me understand more and research about it so I can learn something more that my teacher did not teach me.*

The problems that have been noted in both schools were that very few practical lessons were conducted. The main reason was a lack of laboratory equipment. Teachers also complained about the lack of equipment in school laboratory and were trying to do their best with that which was available. With large classes (average 32 learners per class) setting of practical lessons became difficult with limited resources available.

Teachers' responses to question 4 which required them to reflect on the challenges they face with regard to conducting practice were as follows:

Lack of equipment.
With large classes we have discipline problems especially in grade 10 (45 learners in a class) and also there is insufficient equipment.
Poorly resourced laboratory also pose a challenge.

The subject specialists agreed that a lack of equipment and large class sizes make conducting practical lessons rather difficult. When responding to question 4 (Annexure B4) on problems they encounter when they perform practical lessons, one of the teachers responded:

The only challenge is setting up practicals for large groups with limited resources. There is a need for laboratory assistance.

Unfortunately School B did not have an operational laboratory. From my observations there were no water tap facilities, fire extinguishers nor operational fume cupboard. Learners at this school engaged in practicals that did not require specialised equipment, particularly chemistry practicals. The learning environment itself was not in line with the subject being taught, thus reflecting a poor working and learning environment.

The advantage of practical lessons is that learners are also learning the implicit curriculum, (i.e. safety when in the laboratory, the importance of cooperation, listening skills and respecting the views and opinions of others when working with dangerous chemicals and equipment). Weinburgh and Englehard (1994) argue that learners with poor prior academic performance in science should be encouraged to do laboratory activities. During practical lessons scientific concepts are clarified and reinforced. Learners begin engaging with scientific concepts and experiences via the manipulation of materials during laboratory experiences.

4.2.4 Class size

Learners from both School A and School B felt that the large class sizes for Physical Sciences, made it very difficult to learn. Each class that was observed per school had an average of 32 learners. Some learners were disruptive in class and educators spent more time disciplining learners instead of teaching. With large classes the attention of learners who sit at the back of the laboratory drifts as the lesson progresses. The teacher tends to have difficulty in dealing with such learners as well as completing the lesson for the day. Thus, smaller classes would allow for the educator to give learners individual attention.

4.2.5 Parent Involvement

Parent involvement plays a vital role in a learner's academic performance. Irrespective of ethnic group, research has shown that parental monitoring leads to higher academic achievement due to the fact that parental attention helps learners remain focused at school (Plunkett & Bamaca-Gomez 2003). Based on the results of studies that have looked at the relationship between parent involvement and academic achievement, "parent involvement is positively related expectations and importance of schooling" and by having a positive attitude towards education, a learner is more likely to excel (Ibanez et al 2004). Approximately 80% of learners were unable to get assistance from their parents in Physical Sciences. Many learners in School A were orphans, living with grand-parents or with parents who have never studied Physical Sciences as a school subject. Figure 4.1 indicated that almost 60% of learners had isiZulu as home language.

Based on the history of the Republic of South Africa, most parents (at some stage of their schooling career) as well as grandparents would have been affected and disadvantaged by the previous government system. Further evidence of weak parent involvement was seen in the learners' responses to question 8 (see Annexure A) which stated: "When you are unable to understand something in Physical Sciences, are your parents/brothers or sisters able to assist you at home?" Most (70%) learners responded that they were not assisted. The following were also mentioned:

> *No, I am the first in my house to do Physical Sciences therefore I wait for tuitions or a day to ask my teacher.*
> *No one at home have done physics so I struggle alone because there is no one to help or explain to me.*

No. None from my family did Physical Sciences. They are all helpless.

Nobody assists me because I live with my granny and she doesn't understand a thing I say. I only have smaller brothers and sisters.

I am the oldest sibling and my mother did not do Physical Sciences when she was at school.

Learners, who were living with their parents, said that they were never available to assist them in the Physical Sciences, as they were always working. These are some of the statements they made:

No, at home my books and the grade I do seem to be important to me only, the only time they can assist is when they evaluate my term report and complain on how I'm not getting A's in the subject.

No, my parents are busy or not around.

I don't have access to help at home because the family members who did Physical Sciences don't stay with me.

Learners also mentioned that the only time their parents were involved was when their report card arrived and it reflected poor results. Learners from School B were in a similar situation with no help from parents. Obviously most parents lacked knowledge about Physical Sciences and could not assist their children. Some learners responded by saying:

They don't assist me they always expect me to know everything. I am scared to tell them that I don't understand this subject.

None of my family at home did Physical Sciences in school.

None of them did physics while schooling.

I am the oldest brother at home I don't get assisted and my parents don't know physics they never did it at school.

Those learners (30%) who were able to get assistance at home with Physical Sciences had a brother or sister who had done the subject at school. Few learners thus had received assistance in Physical Sciences from their parents or legal guardians

4.2.6 Learners opinion on the curriculum

The Physical Sciences curriculum is divided into two components, namely physics and chemistry. The contents of each component are rather extensive. Based on the responses, more than 50% of learners from School A and School B found one particular section in Physics very difficult: Mechanics. Learners found the use and selection of equations very difficult, as the learners (L2 English speakers) do not understand what is required to be done. Learners' responses to question 1 (Annexure A) which required them to reflect on the major difficulties they experienced in Physical Sciences were as follows:

> *The language can be a problem for me when it comes to understanding Physical Sciences; the equations being used can be a problem because sometimes you need to change it to get the answer; NOT doing mathematics can be a problem.*
>
> *Doing calculations in mechanics and interpreting the graphs are difficult.*
>
> *Some aspects of mechanics, i.e. how to calculate tension incline planes and how to determine how much of work is done using the given formulas.*
>
> *Mechanics especially the incline plane calculations.*
>
> *The physics part of Physical Sciences, basically the calculations of problems e.g. falling bodies, momentum.*

This trend seems to be ongoing as the National Diagnostic Reports on Learner Performance (2012, 2011, 2010) expressed similar concerns: learners were unable to substitute and were unable to perform mathematical manipulation. Thus, the mathematics part of this section poses a real problem to many learners.

According to the National Diagnostic Report on Learner Performance (2012), the Mathematics and Physical Sciences curriculum should complement each other. It is suggested that teachers of the respective subjects work together. Based on the responses from the teachers at their respective schools and the subject specialist, time is a limiting factor. With regard to time allocation for the teaching of Physical Sciences, teachers had the following to say (question 10, Annexure B4):

No, too much assessment tasks and too little time.
No, more time is required to teach sections properly.

The subject specialist responded to question 10 (annexure B4) as follows:

It seems overloaded because there are a lot of assessments that has to be done e.g. controlled tests, June exams, and trial exams take up a lot of time.

The Subject Assessment Guidelines for Physical Sciences require too many assessments to be covered within a short space of time. This leaves the Physical Sciences teacher with little time to teach the required mathematical skills especially for those learners who do Mathematical Literacy.

Under the section of Chemistry, the main area identified by learners as a problem was the section on Chemical Change where learners should calculate the equilibrium constant. Most learners in School A and School B reported difficulty in performing the mathematical calculations especially when they had to compute the value of an unknown variable. A learner said, “I am having difficulty in calculations in the section chemical change”.

The trend among learners, as well as teachers and subject specialist was that the Physical Sciences syllabus is ‘overloaded’ with too much work and too little time left for teaching. Teachers felt that the syllabus needs to be revisited and Physics and Chemistry separated into separate entities which would help to improve the performance. Learners also feel that a separation of Physics and Chemistry would be helpful as some feel they are better in one and not the other.

Teachers' views were as follows:

Reduce the syllabus content, it is too much especially grade twelve, or perhaps the curriculum should be re-evaluated and separate physics and chemistry into two individual subjects.
More periods, Maths. Literacy. Pupils must not do physics; only pupils with above eighty percent in grade nine Maths should do physics'.
I think that the subject should be separated into Physical and Chemistry Sciences. The learners per class should be reduced for better or more teacher and student time.
Do experiments, separate chemistry and physics...
I feel that the separation of mechanics (physics) and chemistry would make it easier for everyone.

Learners' views were as follows:

Understanding physics is hard it's a complicated subject with too many areas to cover in a short space of time.
There is a work overload and too little time.
I think that Chemistry and mechanics (Physics) should be separated as different subjects. It will be easier.
We need to be able to gain access to laboratories and work practically with experiments.
More practical work can be done. Government can provide free tuition in different languages.

The comments indicated by the participants illustrate a need to teach and learn physics and chemistry separately.

4.3 CONCLUDING REMARKS

A number of underlying factors have been identified as contributors to the poor performance level of grade 12 learners in public schools in the Pinetown District.

From the research conducted it is evident that better laboratory facilities are required in the schools, so that more practical lessons can be conducted. Parent involvement has also been discussed. The current syllabus is extremely long and the time allocation is insufficient to adequately complete the given syllabus; thus there is a need that the curriculum be separated into Physics and Chemistry as individual subjects at the school level. The availability of a textbook for every child has been discussed.

CHAPTER 5
FINDINGS, FINAL CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the summaries of the findings with reference to the problem statement, research question and aims. Recommendations for improvement of Physical Sciences teaching and learning based on the analysis of data are also presented. Lastly, I suggest areas for future research.

5.2 SUMMARY OF THE FINDINGS

The conclusions that are drawn are based on the findings. A number of factors have been identified as reasons for poor performance in Physical Sciences in the two schools under investigation. These factors include a lack of resources, language of learning and teaching (LoLT), learners doing Mathematical Literacy instead of Mathematics, the socio-economic status of learners, parent involvement, large classes, the developmental level of learners, and the curriculum.

5.2.1 Medium of Instruction

The home language of a learner and the medium of instruction or LoLT at schools affect learner performance in a subject. When learners are unable to interpret a question in the examination, the chance of learners providing the correct explanation is not good.

Learning a second language is not an easy task for an adult or child; in the case of children it may be more difficult as they may feel incompetent and not want to be embarrassed among friends (Zehler 1994: 4). This could be a reason that many English second language learners do not open up in a classroom and ask questions where they do not understand the content. Zehler (1994:17) argues that when working with English L2 learners, the use of their home language was very helpful in the learning content material. Likewise, learners in the above two schools found that when they explain concepts to each other in their own home language, they understand better.

5.2.2 Knowledge of mathematics

Every learner is unique; however, certain factors hinder the performance of a learner irrespective of his/her uniqueness. When OBE was introduced, learning was visualised as a process or journey that a learner should take before reaching the end result, that is, the outcome. OBE encouraged group-work, learner centeredness and activity-based education. Thus, it requires that cooperative learning methods (e.g. group investigation) be used. This allows learners to learn from each other; develop communication skills; make use of the prior knowledge in order to build on; and develop existing knowledge. Subjects are no longer taught in isolation, instead there is integration. No piece of knowledge exists in isolation. It is all linked to a bigger system and every system consists of several parts that work together in order for it to function as a whole (Higgs & Smith 2006:27).

However, from the results obtained above, the aspect of integration is very difficult to achieve for those learners who do Mathematical Literacy as opposed to those who did Mathematics. Mathematical Literacy does not incorporate the skills and higher knowledge that is required for Physical Sciences. This combination of Mathematical Literacy and Physical Sciences should not be allowed by the various Education Departments.

A clear indication that Mathematical Literacy is inadequate for Physical Sciences learners is found in the National Diagnostic Report on Learner Performance 2012 for National Senior Certificate Examination for Physical Sciences. November 2012 Paper 2 required that the learners use a quadratic formula to solve for ‘x’, and this formula is not taught in Mathematical Literacy. As a result many candidates lost marks.

5.2.3 Physical Sciences content in the curriculum

The Physical Sciences curriculum, which incorporates both physics and chemistry, presents learners with a large amount of work to assimilate and accommodate. Thus, a possible division of the curriculum into physics and chemistry as separate entities in the South African education system may help to improve the performance level of many learners. For some learners chemistry may be a stronger point than physics or vice versa; this separation as done overseas can help learners excel and possibly increase the number of learners taking up scientific fields of study. Piaget's theory of cognitive development is important when it comes to evaluating the curriculum (Simatwa 2010:371). It is essential that teachers understand that the developmental rate will differ among learners. They need time to digest what has been presented to them.

5.2.4 Resource availability

To date, all grade 12 learners have been under the OBE system. With the introduction of CAPS syllabus in grade 12 in 2014, the practicals across all schools will be standardized. However, many of these practicals require advanced equipment, which many public schools such as the two participating schools lacked. There is likelihood that many other schools in the province are also under-resourced in terms of laboratory equipment. The question can be posed as to how the schools allow for optimum performance and effective teaching and learning with this revised curriculum, if resources are not available.

The availability of resources in schools for both theory and practical lessons is essential for the success of the subject. Learners must have textbooks available to them in order to engage in self-activities and self-learning. Every learner should be in possession of a text book. The availability of equipment for the practical aspect is essential to help learners put the theory into practice. One of the principles of OBE is learning through hands on experience; clearly this principle is not met in the above two schools.

5.2.5 Socio-economic status of learners

Most of the learners in the two schools came from underprivileged homes. For learners whose parents can afford to send them to private schools, the purchase of study guides and extra lessons is no problem. However, for learners in the above two schools, the financial status of parents is of concern as these learners are not only doing Physical Sciences but six other subjects, that require them to purchase study guides as well. If learners were provided with text books, it would be of great help to those who cannot afford the option of extra lessons and study guides.

The Constitution of the Republic of South Africa clearly states that every child has the right to education. The standard of this education should be the same for every child across the board, irrespective of race, gender, and social class.

5.2.6 Parent Involvement

Parent involvement plays a vital role in the academic life of a learner. In the above two schools learners have received very little support from their parents. Parents need to take an active role in their child's schooling. By parents working together with teachers by simply taking an interest in the learner's work, there is a greater chance of improving Physical Sciences performance.

5.2.7 Class size

Many learners from the schools studied complained of too large classes. Practicals and theory lessons in large classes, together with limited resources, become very difficult and more time was spent on disciplining learners rather than teaching and learning. Smaller classes benefit all learners; however, learners who perform poorly in various subjects would benefit the most. When the class size is too large, learners tend to lose focus on the task because instruction is focused on the class as a whole rather than on individual learners (Blachford et al 2011). Smaller class sizes benefit learners once they enter high school especially in areas of reading and science (Konstantopoulos & Chung 2009).

5.2.8 Knowledge of basic science concepts

Many learners from the schools under investigation were not at the level of formal operational thinking and this is evident from the results of the given activity. Physical Sciences learners especially those at grade 12 must have the skills of abstract thinking. According to Piaget's theory of cognitive development, students at high school level are in the formal operations stage; however, only 30 to 35% of secondary school learners attain the formal operational stage. During this stage intelligence is shown through the use of symbols related to abstract knowledge (Woolfolk 2007).

5.3 RECOMMENDATIONS

Based on the findings of this research into the reasons for poor performance in Physical Sciences by schools in the Pinetown District in Kwa-Zulu Natal, the researcher recommends that schools ensure that:

- Text books are made available to all learners. Should funds not be available, the schools need to embark on some sort of fundraising activity to ensure that resources such as text books are available for effective teaching and learning to take place.
- Physical Sciences laboratories are in working order with the necessary equipment.
- The laboratory reflects the subject being taught and creates a positive teaching and learning environment.
- Learners are appropriately assisted with regards to the selection of subjects at the FET phase.
- Physical Sciences class sizes are kept to a minimum as far as possible.
- Physical Sciences learners do pure mathematics.
- Children regularly engage with the parents.
- Activities are provided which stimulate the cognitive development of every learner.

Other responsibilities should be attended to by the Department of Education:

- Revisiting the Physical Sciences curriculum with the possibility of separating physics and chemistry into two separate subjects in the FET phase.
- Visits to schools to assess the laboratory status of schools.
- Adequate funding for new updated text books in line with the current syllabus. Make it a policy that learners who choose to do Physical Sciences at grade 10 level have to do Mathematics and not Mathematical Literacy. Study guides for Physical Sciences should be written in languages other than English (e.g. isiZulu).

Parents should also be active stakeholders in the provisioning and upgrading of their children's education systems. Parents are expected to:

- Be actively involved in their children's academic process, by regular monitoring of their children's performance.
- Encourage their children to read more, thus improving language. By reading learners would develop a better understanding of words and meaning. To assist learners with this aspect parents should ensure that their children have adequate reading material.

5.4 FURTHER RESEARCH

Although this study has achieved its goal of finding reasons for poor performance in the schools identified, there is room for further studies. This research focused on the learner; however, some teachers who choose Physical Sciences as a subject didactic are very well trained in theory, but have very little to no experience with conducting practical activities. Due to the inexperience and for the safety of all learners, they may not know how to conduct practical lessons involving dangerous chemicals. Further research in the following areas will be encouraged:

- Further research that focuses on the Physical Sciences pre-service teacher education in order to find methods to improve teaching and learning strategies in the classroom, thereby ultimately helping to improve learner performance.

- Research project to determine whether the Natural Sciences syllabus for grades8 and 9 provides learners with the basic foundations required for Physical Sciences.

5.5 CONCLUDING REMARKS

This study presented the factors responsible for the poor performance of learners in Physical Sciences in the Pinetown District in Kwa-Zulu Natal. There is no single factor that can be outlined as a cause for poor performance in learners. The dynamics of every child differs, from the socio-economic status to parent involvement. Although there have been recommendations made for the schools, the Department of Education and parents, correcting the situation is no easy task. All stakeholders in the education sector should play their role so that the education that is provided to learners is of good quality.

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ANNEXURE A

LEARNER INTERVIEW QUESTIONS

Answer the questions below to the best of your ability. Please feel free to elaborate on your responses. Your responses are confidential. Therefore you and requested NOT to write your name or the name of your teacher/school anywhere on the pages or mention it in your responses.

1. What are some of the major difficulties you as a grade 12 learner experience with Physical Science?

2. Does your school provide you with the required text books or did you have to buy your own?

3. Do you engage in practical activities at school for Physical Science? If so, does it help to improve your understanding of the subject?

4. Teaching and learning is a two-way process with the learner and educator working together. Do you agree with this statement for Physical Sciences?

5. For those who do Mathematics do you find problem solving in Physical Science easier?

6. For those who do Mathematical Literacy do you find problem solving in Physical Science difficult?

7. In your daily class lessons, are you able to assist your friends and vice versa thereby helping to improve your understanding?

8. When you are unable to understand something in Physical Science, are your parents/ brothers or sisters able to assist you at home?

9. Are extra lessons in Physical Science outside school an affordable option for you?

10. If Physical Science were taught to you in your home language, would you have a better understanding of the subject and your performance in it would improve?

11. What in your opinion as a learner can be done to improve learner performance in Physical Sciences?

ANNEXURE B1

EDUCATOR QUESTIONNAIRE 1

This questionnaire seeks information on the **educator's encouragement of Physical Sciences in the FET classroom**. The data gathered from this questionnaire is for research purposes only. All respondents are to remain anonymous.

INSTRUCTIONS

Please circle the appropriate number on the questionnaire.

Section A: Personal details

1. Your gender:

Male	1
Female	2

2. Educator's Age

21-31	1
32-45	2
45-50	3
60>	4

3. Are you in possession of a qualification that warrants you to teach Physical Sciences (specialisation in Physical Sciences at a tertiary level)

Yes	1
No	2

4. Years of teaching experience (teaching Physical Sciences)

< 2	1
3-5	2
6-9	3
10 >	4

5. Years of teaching experience in the **FET phase**

< 1 1

2-4 2

5-8 3

9 > 4

6. Geographical area of school

Urban/Semi-urban 1

Rural 2

Section B: Educators' Encouragement of initiative towards Physical Sciences

Please indicate the extent to which you agree or disagree with each statement listed below by circling the number that reflects your view according to the following scale:

Disagree 1

Neutral 2

Agree 3

1. I must ensure that my learners are comfortable in the learning environment.	1	2	3
2. I allow learners decide on how to approach a given task	1	2	3
3. I let learners finish a given task although I want to move on.	1	2	3
4. I involve learners in non-competitive activities.	1	2	3
5. I must ensure that all learners are catered for.	1	2	3
6. I must ensure that the learning environment (the classroom) is safe.	1	2	3
7. I must ensure opportunity is created for cooperative learning to take place.	1	2	3
8. I must vary my teaching strategy to accommodate all learning styles.	1	2	3
9. I must teach learners to respect each other.	1	2	3
10. I should allow learners to explore their creativity in the classroom.	1	2	3

11. It is my responsibility to ensure the safety of learners in my classroom.	1	2	3

Section C:

Please indicate the extent to which you agree or disagree with each statement listed below by circling the number that reflects your view according to the following scale:

Disagree 1

Neutral 2

Agree 3

Encourage initiative in many aspects of classroom work.

1. I must get learners to come-up with ideas for projects	1	2	3
2. I must get learners to listen to each other.	1	2	3
3. I must ensure group work.	1	2	3

Make use of sense of initiative in work with basic skills.

1. I must ensure that I develop reading skills in all learners.	1	2	3
2. I must ensure that the basic writing skills of all learners are developed.	1	2	3
3. I must see to it that all learners are able to identify basic concepts in my subject.	1	2	3
4. I must ensure that all learners have developed numeracy skills.	1	2	3

Make sure that each child has a chance to experience success.

1. I encourage all learners to have a chance at answering questions.	1	2	3
2. I ensure that all learners have a turn at class games.	1	2	3
3. The response I give to learners must always be in a positive manner.	1	2	3
4. I will see to it that each child has an opportunity to share his/her understanding with the class.	1	2	3

Avoid scolding a child or devaluing a child because he/she tries something on his/her own.

1. I will correct a child in a positive manner.	1	2	3
2. I will show explain to a child why something wrong.	1	2	3
3. I will show appreciation for the efforts the child has made.	1	2	3

SECTION D: COMMENTS/ANY ADDITIONAL INFORMATION

DATE: _______________

<u>THE END</u>

ANNEXURE B2

EDUCATOR QUESTIONNAIRE 2

This questionnaire seeks information on the educator's understanding of being a mediator of learning thus successfully implementing the National Curriculum Statement Grade Physical Sciences 10-12 (General). The data gathered from this questionnaire is for research purposes only. All respondents are to remain anonymous.

INSTRUCTIONS

Please circle the appropriate number on the questionnaire

INSTRUCTIONS

Read each of the following statements, and mark each one in the appropriate column.

(4) = Always (3) = Sometimes (2) = Hardly ever (1) = Never

	(1)	(2)	(3)	(4)
I am flexible, and try to accommodate the divergent needs of learners.				
I create a sense of purpose in my learners and encourage them to participate.				
I build my learners self-esteem and give them a sense of competence.				
I have arranged my classroom in such a way that learning is encouraged.				
I can handle conflict in a positive way, and I also encourage my learners to practice deliberate self-control and self-discipline.				

I always explain to my learners the meaning, value and purpose of a learning activity.				
The learners in my class are, in general actively involved in my class.				
I mediate learning; I do not give out information.				
I encourage learners to take risks, and to develop a positive, enthusiastic attitude to problem solving and other complex tasks.				
I encourage learners to understand the applicability of ideas, principles and strategies outside the classroom.				
I give learners plenty of time to discover information for themselves and to work individually.				
I provide learners with ample opportunity to work in groups, to learn and support each other.				
Learners have the chance to assess themselves or their friend before I do my own assessment.				
I try to make the learners aware of their own learning process.				

COMMENTS/ANY ADDITIONAL INFORMATION

DATE: ____________

THE END

ANNEXURE B3

EDUCATOR QUESTIONNAIRE 3

This questionnaire seeks information on the dynamics of a Physical Science laboratory **government schools in KwaZulu-Natal Pinetown District**. The data gathered from this questionnaire is for research purposes only. All respondents are to remain anonymous.

Instructions: Please circle the appropriate number on the questionnaire.

Section A: Learning Milieu

1. Your school has a Physical Science laboratory that you use to teach.

Yes 1
No 2

2. Your laboratory is adequately equipped to conduct practical lessons.

Yes 1
No 2

3. Your laboratory reflects clearly the subject being taught.

Yes 1
No 2

4. The school provides a Physical Science text book for every grade 12 learner in your Physical Science class.

Yes 1
No 2

Section B: Learner Dynamics

5. The medium of instruction at your school is English.

Yes 1
No 2

6. The home language and medium of instruction at your school is one and the same for all Physical Science pupils.

Yes	1
No	2

7. Your average class size for Physical Science is:

0-15	1
16-26	2
27-36	3
37 >	4

8. Every learner in the grade 12 Physical Science class is in possession of a Physical Science text book.

Yes	1
No	2

9. All grade 12 learners who do Physical Science at your school also do Mathematics and NOT Mathematical Literacy.

Yes	1
No	2

10. All grade 12 learners are able to comprehend and complete the mathematical part of Physical Sciences with no problem.

Yes	1
No	2

11. All learners are punctual to the Physical Science lesson irrespective of the time of the lesson (e.g. period, period 5 etc.)

Yes	1
No	2

12. All Physical Science learners show dedication and commitment to the subject.

Yes	1
No	2

13. The daily attendance of Physical Science learners to school is good.

Yes 1

No 2

ANNEXURE B4

EDUCATOR INTERVIEW QUESTIONS

1. As an educator of Physical Sciences what are the major problems that you face when it comes to teaching the subject?

2. Does the availability of resources affect your teaching strategies used? Explain

3. Are you confident when it comes to doing practical lessons?

4. Do you experience any problems when it comes to conducting practical lessons? Explain.

5. Is the cognitive level of the grade 12 learners at an acceptable level?

6. Do learners whose home language differ from the medium of instruction, have a problem with understanding the content of Physical Sciences?

7. From your observations as an educator does the socio-economic status per se of a learner affect his/her performance in Physical Sciences? Explain

8. In terms of the policies that have been introduced for Physical Sciences by the Department of Education, do you feel it is suitable to government schools?

9. Does the performance level of a grade 12 learner in Physical Science differ for a learner who does Mathematics compared with a learner who does mathematical Literacy? Explain

10. With the given grade 12 curriculum for Physical Sciences is the time allocated to complete the syllabus sufficient?

11. What in your opinion should be done to help improve the rate of Physical Sciences at your school?

ANNEXURE C

Learner non-standardised test: One

This survey seeks information on the Grade 12 Physical Science learner. The data gathered from this survey for research purposes only. All respondents are to remain anonymous.

Instructions:

Please circle the appropriate number on the survey.

Section A: Personal Information

1. Your gender:

Male	1
Female	2

2. Your age group:

16-18	1
19-21	2

3. Are you in grade 12 in 2013?

Yes	1
No	2

4. Your home language is:

English	1
IsiZulu	2
Afrikaans	3
Other	4

5. You have chosen Physical Science because:

You felt it would be interesting	1
Peer pressure	2
You wish to pursue a career in science and technology	3

6. Your socio-economic status can de described as;

High	1
Average	2
Below average	3

Section B: Schooling

7. You are always in school before the start of the first period.

Yes	1
No	2
Sometimes	3

8. You are in possession of a Physical Science text book, that you take home daily.

Yes	1
No	2

9. You are doing Mathematics and NOT Mathematical Literacy.

Yes	1
No	2

10. You attend extra Physical Science lessons outside school

Yes	1
No	2

11. You spend at least an hour a day revising/reading/ studying Physical Science.

Yes 1

No 2

12. You have no problem understanding the concepts of Physical Science.

Yes 1

No 2

13. Do you regret choosing Physical Science as a subject?

Yes 1

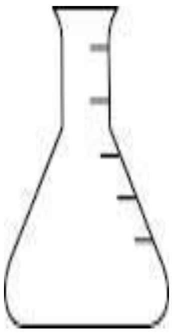
No 2

ANNEXURE D

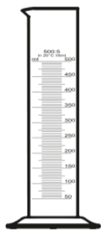
LEARNER ACTIVITY

The questions below are based on fundamental concepts of Physical Science, which every grade 12 learner should be familiar with. Complete the questions below without the aid of your notebook or text book.

1. When dealing with acids and bases, as a safety measure we always add base to acid and never acid to base. Is this statement true? (2)
2. Identify the laboratory apparatus below, using correct scientific terminology. (3)



a)----------------



b)____________

c) _______________

3. Sodium Chloride is commonly known as:______________________ (2)
4. Convert the following from m^3 to dm^3 (2)
   4.1.1. $250m^3$ = ______________
   4.1.2. $1050m^3$ = _____________
5. Balance the following chemical equation:
   5.1.1. $SO_2 + O_2 \rightarrow SO_3$ (2)
   5.1.2. How many elements are there in the above reaction? (2)
   5.1.3. Name the element from the above that is important to man? (2)

6. Chris is walking down a path and comes to a fork in the path, one path marked Path A, and the second marked Path B. There is a sign at the head of each path, describing that path:

Sign A: Path A is 1 mile long due east .Path A is 3 feet wide. Path A has a snack bar by the path. Path A at the half way point has a bridge which is down for construction, making the path impossible. Path A is paved with asphalt.

Sign B: Path B is 1 mile long due west. Path B is 2 feet wide. Path B has no snack bar Path B has no bridge and is open all the way. Path B is a dirt path.

Now, you as a Physical Science learner are required to choose the best path with the goal in mind of reaching a destination 3 miles down the path after the point where paths A and B have merged and have become one path again. You are to compare and contrast the good and bad points about both paths A and B, and choose the path which logically is better, given the goal of reaching your destination. (5)

Total :20