

**AN INVESTIGATION INTO THE LOW PASS RATE IN  
SCIENCE AND MATHEMATICS IN SELECTED SCHOOLS IN  
THE NORTHERN AREAS, PORT ELIZABETH**

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## **DECLARATION**

I, Jo-Anne Keble, hereby declare that this treatise is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

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Jo-Anne Keble

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Date

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## **ABSTRACT**

Mathematics and science are key areas of knowledge and competence for the development of an individual, and the social and economic development of South Africa in a globalising world. Since 1994, the new democratic government in South Africa has emphasised the centrality of mathematics and science as part of the human development strategy for South Africa. Performance in this area is one of the indicators of the health of the South African educational system. It makes an important contribution to the economy and has been a contributor to inequalities of access and income. The twenty-first century is characterised by exponential growth and rapid change, which will be mainly based on information technology. The major asset in any successful country is its inventiveness in science and technology, rather than its abundance of labour or its natural resources. Therefore, it is important that school education should prepare the youth in scientific and technological fields to cope with, and contribute to, the well-being of their country.

Science teachers have been under more strain than teachers in other subjects simply because science is generally viewed as a practical subject, and the teaching thereof is complicated by the fact that the majority of schools have large classes and few resources to teach science. This is in part because the majority of science teachers in South Africa are either under qualified or not qualified to teach the subject. As a consequence of the lack of effective classroom practices and related theoretical debates, especially in South Africa, many new approaches to professional development have begun to emerge. Most of these are aimed at science and mathematics teachers. The low success rate of Grade 12 learners in science and mathematics has a negative impact on the overall pass rate of Grade 12 learners. It has a negative influence on the future prospects of learners who cannot successfully pursue careers of their choice. The poor grades achieved in these subjects discourage learners from pursuing key careers that are critical in contributing to the well-being of the country. The lack of fundamental professionals such as teachers, doctors, scientists, and other scientifically oriented professionals is also impeding the growth of the economy. An important goal of this study was to identify key significant variables that contribute to these factors and to provide an understanding of causative factors of the low pass rate of Grade 12 learners in science and mathematics.

In this study, data was collected from Grade 12 learners, Grade 12 educators, and principals in the targeted schools. The research investigated contributory factors to low success rates in science and mathematics subjects at Grade 12 level at the schools under study. In order to achieve the aim of the study, qualitative research methods were followed. The objectives of this study were to provide an understanding of causative factors of the low pass rate in science and mathematics of Grade 12 learners, identify key significant variables that contribute to these factors, and for this reason, a qualitative approach to the study was pursued. The researcher made use of questionnaires and interviews to collect qualitative data. Participants included high school principals, Grade 12 science educators, Grade 12 mathematics educators, and Grade 12 science and mathematics learners. Participants were purposely chosen because each one of them had experience of, and views on science and mathematics education at Grade 12 level.

The study established that there are indeed various factors that contribute to the low success rate in science and mathematics, and that these factors are not solely attributable to the school environment. These factors include access to resources, poor subject choice, numeracy and literacy skills, drawbacks of Grade 12 syllabus, socio-economic status, language usage, insufficient content knowledge, and insufficient exposure to physical science. Suggestions and recommendations to address these above challenges have been espoused in the study.

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# CHAPTER ONE

## GENERAL OVERVIEW

### 1.1 INTRODUCTION

According to Howie (2003: 2), numerous reports of shortcomings in the teaching and learning of mathematics and science education in South Africa have come to light. Because the standard of scientific and mathematical literacy is generally poor in the entire schooling system, it is imaginable that such a system will not be able to turn out enough learners who qualify to enrol at universities to follow further science and mathematics studies.

Mathematics and science are key areas of knowledge and competence for the development of an individual, and the social and economic development of South Africa in a globalising world (Reddy, 2005: 125). Since 1994, the new democratic government in South Africa has emphasised the centrality of mathematics and science as part of the human development strategy for South Africa. Performance in this area is one of the indicators of the health of the South African educational system. It makes an important contribution to the economy and has been a contributor to inequalities of access and income (Reddy, 2005: 125).

A new national curriculum was introduced more than ten years ago in South Africa to address educational inequalities of the past. The implementation of Curriculum 2005, hereinafter refers to as (C2005) in secondary schools in the Further Education and Training (FET) band (Grades 10 to12) started in Grade 10 at the beginning of 2006 (DOE 2003: 8). The revision of the school curriculum in South Africa, towards a more open and learner-centred system of Outcomes Based Education (OBE), has changed the environment in which teachers work. The introduction of OBE in South Africa has placed a strain on teachers as the education system meanders its way towards the shifting goal posts of the new curriculum (Johnson, Scholtz, Hodges & Botha, 2003: 85).

Johnson, *et al.* (2003: 85) are of the opinion that science teachers have been under more strain than teachers in other subjects simply because science is generally viewed as a practical subject, and the teaching thereof is complicated by the fact that

the majority of schools have large classes and few resources to teach science (Johnson, *et al.*, 2003: 85). As a consequence of the lack of effective classroom practices and related theoretical debates, especially in South Africa, many new approaches to professional development have begun to emerge. Most of these are aimed at science and mathematics teachers (Grayson & Ngoepe, 2003: 11; Southwood, 2002: 30). This is in part because the majority of science teachers in South Africa are either under qualified or not qualified to teach the subject (Kahn, 1995: 441).

A number of factors have been reported pertaining to the poor performance of pupils in the matriculation examinations and in general (Kahn, 1995: 442). These include inadequate subject knowledge of teachers, inadequate communication ability of pupils and teachers in the language of instruction, lack of instructional materials, difficulties experienced by teachers to manage activities in classrooms, the lack of professional leadership, pressure to complete examination-driven syllabi, heavy teaching load, overcrowded classrooms, poor communication between policy-makers and practitioners, as well as lack of support due to shortage of professional staff in the Ministries of Education (Howie, 2003: 1).

Mzokwana (2008: 53) is of the opinion that assessment plays an important part in curriculum implementation as it helps to identify learning problems, to follow learner progress, give feedback to learners, and provide evidence of learners' height of success. According to Kelly (2004:126), the essence of good teaching is that one should constantly be attempting to gauge the levels of pupils' learning in order to lead them to further development. Assessment in the new curriculum plays a vital role in informing the learner and the teacher about the learner's progress. When learners are assessed, a variety of forms can be used. The Department of Education (1998:12) states that the performance should be measured against specific outcomes, using a wide range of methods, tools, and techniques such as informal monitoring by observation, formal use of appropriate standardized tests, interviewing, self-assessment, peer assessment, project work, and assignments. According to the National Education Policy Act (Act 27 of 1996), educators should understand that assessment is an essential feature of the teaching and learning process.

House (1988: 634) rightly predicted that the twenty-first century would be characterised by exponential growth and rapid change, which will be mainly based on information technology. Accordingly, Stean (1988: 88) sees the major asset of any successful country as its inventiveness in science and technology, rather than its abundance of labour or its natural resources. Therefore, it is important that school education should prepare the youth in scientific and technological fields to cope with, and contribute to, the well-being of their country (Dekker & de Laeter, 1994: 25).

According to Robottom and Hart (1993: 591), a greater number of science graduates results in a more skilled, and therefore a more productive workforce, which in turn contributes to an internationally more competitive nation and redressing the balance of trade problems. Science is considered to be among the requirements for creating wealth and improving the quality of life. If science is considered to be among the requirements for creating wealth and improving the quality of life, the importance of quality science and mathematics education is obvious. The low success rate of Grade 12 learners in science and mathematics has a negative impact on the overall pass rate of Grade 12 learners. It has a negative influence on the future prospects of learners who cannot successfully pursue careers of their choice. The poor grades achieved in these subjects discourage learners from pursuing key careers that are critical in contributing to the well-being of the country. The lack of fundamental professionals such as teachers, doctors, scientists, and other scientifically oriented professionals is also impeding the growth of the economy.

For the low pass rate found in Grade 12 in the two schools, there must have been pre-existing factors that were "fertile ground" for poor results in science and mathematics subjects in particular. Studies in South Africa have investigated and reported on different factors that affect teaching and learning in general, and those of mathematics and science in particular. The recurring poor performance in these subjects calls for a concerted effort of measures that will help improve the status quo. One important element in an endeavour to find solutions to the problems of poor performance by learners is to undertake investigations that will help inform stakeholders (Legotlo, Maaga, & Sebego, 2002: 115).

The low pass rate in science and mathematics at Grade 12 level is an indicator of problems in science and mathematics education in South Africa. MacDonald and

Rogan (1988: 234) found that in South Africa, there were huge obstacles against efforts towards human power development. MacDonald and Rogan (1988: 234) argue that some school environments demotivate learning. School environments that can be demotivating include poor physical structures such as dilapidated buildings, and lack of facilities such as science equipment, laboratories, and libraries, particularly in rural schools. According to Henderson and Wellington (1998: 35), for many learners, the greatest barrier to learning science is language. The problem is that like many other African countries, South Africa has developed science curricula and content upon Western trends, and teaches science mainly in English or Afrikaans. This study investigates the causative factors of low pass rate, with specific reference to science and mathematics in two selected schools in the Northern Areas of Port Elizabeth for the period 2005 to 2010.

## **1.2 THE PROBLEM STATEMENT**

The low pass rate in science and mathematics is of great concern. The following information obtained from one of the selected high schools in the Northern Areas in Port Elizabeth emphasizes the extent of the problem. In 2008, 53% of learners passed mathematics, 38% passed in 2009, and 37% passed in 2010. For physical science, in 2008, 53% passed, 43% passed in 2009, and 25% passed in 2010.

The low success rate of Grade 12 learners in science and mathematics has a negative impact on the overall pass rate of Grade 12 learners. Learners who failed science and mathematics at Grade 12 level usually passed all their other subjects, but then failed Grade 12 because they failed either science or mathematics.

The low success rate in science and mathematics has a negative influence on the future prospects of learners who cannot successfully pursue careers of their choice. Learners who set their hopes on entering fields of study that require science and mathematics subjects are being discouraged because they are failing science and mathematics at Grade 12 level thus disallowing them to pursue careers of their choice.

The poor grades achieved in these subjects discourage learners from pursuing key careers that are critical in contributing to the well-being of the country. South Africa is in need of suitably qualified teachers, doctors, scientists and many other scientifically

oriented professionals. With learners failing science and mathematics at grade 12 level, the need of such professionals in South Africa is still widespread.

### **1.2.1 Research question**

What are the causative factors of low pass rate in science and mathematics?

### **1.3 MOTIVATION FOR THE STUDY**

The research stems from the researcher's observation of poor Grade 12 results in science and mathematics subjects in Port Elizabeth. The concerns of the researcher are that various factors which are challenges that exist even before learners write their examinations could be regarded as predisposing learners to a high failure rate. This has sparked interest in the investigation of these factors in order to come up with strategies, which could stimulate constructive suggestions and recommendations, which could act as guidelines to management practices of educationists in order to enable them actively and creatively to manage the poor pass rate in mathematics and science. As the researcher is a teacher by profession, the choice of the topic is dictated by a deep-seated interest in teaching and learning. Every country needs to consider the question of how to prepare its youth to be effective citizens in a scientific, mathematical, and technological world (Winther & Volk, 1994: 50).

### **1.4 OBJECTIVES OF THE STUDY**

- To provide an understanding of causative factors of the low pass rate of Grade 12 learners in science and mathematics
- Because the low success rate in science and mathematics has a negative influence on the future prospectus of learners who cannot pursue careers of their choice, an important objective of the study will be to identify key significant variables that contribute to these factors.
- Because Grade 12 learners are being discouraged from pursuing key careers that are critical in contributing to the well-being of the country, an important objective of the study will be to assist role players in addressing causative factors of low success rates in science and mathematics.
- It is expected that the study can assist in addressing the challenges concerned with attaining higher levels of pass rates of Grade 12 learners in science and mathematics.



## **1.5 ETHICAL CONSIDERATIONS**

Ethics illustrate what is or is not correct to do, or what moral research procedure is involved. Neuman (2003:116-118) suggests that the researcher has a moral and professional obligation to be ethical, even when research subjects are unaware of or unconcerned about ethics. Neuman (2003: 124) further recommends that informed consent to participate in the study must be sought from the participants. That informed consent must contain the following:

- A brief description of the purpose and procedure of the research.
- A statement of any risks or discomfort associated with participation.
- A guarantee of anonymity and the confidentiality of records.
- A statement that participation is completely voluntary and can be terminated at any time without penalty.
- A statement of any benefits or compensation provided to subjects and the number of subjects involved.
- An offer to provide a summary of findings.

After applying for approval to the relevant committees at the university, the researcher will approach principals and teachers of the two selected schools to obtain permission to conduct the study. All participants will be fully informed about the purpose of the study, and also assured of anonymity and privacy during the study. Participants will be guaranteed that they will be at liberty to decline to continue with the study at any stage if they so wish. Participants will be informed that no remuneration will be awarded for involvement in the study. Interviewees' permission for tape recording will be sought prior to interviewing. All names and addresses of participants will be deliberately omitted from the study. Questions that encourage respondents to answer in a particular way are biased. Therefore, the wording of the interviews and questionnaires will be cautiously selected so as to minimise the impact of biasness (Babbie & Mouton, 2001: 237).

## **1.6 DELIMITATION OF THE STUDY**

It is advisable to say what is not intended with the research. This helps the researcher to apply her energies to the problem statement and not waste time on

matters that are not directly associated with the problem. With this in mind, this study will confine itself within the South African context, but will adopt a comparative dimension. Although science and mathematics subjects are challenging on the whole, the study will focus on Grade 12 learners only. While schools have many problems, the focus of the study will be on the low Grade 12 mathematics and science pass rate. Time constraints within the confines of this study will not allow for the exploration of information that does not fall within the ambit of this study, but such information will form the basis for further study.

### **1.7 RESEARCH METHODOLOGY**

A literature review will be used as one of the data gathering techniques. Mouton (2001: 86, 87) states that a literature review represents the first phase of the empirical study and entails reviewing other authors' work in a specific field of study. This is done to:

- Save time and avoid duplicating an existing study.
- Discover what are the most recent theories and empirical findings about the subjects.
- Identify instruments proven to be reliable and valid, which could be used in the study.
- Identify the most widely accepted definitions of key concepts in the study field.

The method of data collection will adopt a qualitative approach. Qualitative research is a type of research in which the researcher collects first-hand information obtained directly from participants (Miles & Huberman, 1994: 10). The research will be conducted at two schools in the Northern areas of Port Elizabeth. The two schools were chosen because they both offer science and mathematics to Grade 12 learners.

The sample size will comprise of respondents from the schools (School A and School B, which cannot be named in compliance with ethical consideration of confidentiality) which will include 2 school principals (one from each school), 2 mathematics teachers (one from each school), 2 physical science teachers (one from each school), and 46 science and mathematics learners (23 learners from each school). The sample will be purposely chosen because of the fact that all the respondents are directly linked to the teaching and learning of science and mathematics at Grade 12 level. The learners will be chosen for the study on the

basis that they are to be enrolled at the two schools and are Grade 12 science and mathematics learners. The teachers and principals will be chosen on the basis that they teach at the two selected schools.

Data will be gathered from respondents of the two selected schools by means of questionnaires. A total of 23 science learners and 23 mathematics learners, 2 physical science teachers, and 2 mathematics teachers. Face-to-face interviews of the principals will take place at each of the two selected schools, in order for the researcher to elicit as much information as possible from the respondents. Open-ended questionnaires will be administered to all of the respondents. The questionnaires will be structured in such a way as to allow the respondents ample opportunity to explain their stance on the topic.

Murray (2003: 66) defines a questionnaire as a printed set of questions used to gather facts and respondents' opinions. Davies (2007: 82) states that questionnaires are aimed at facilitating communication either in writing, in the form of a conversation, or electronically. A questionnaire will be designed to obtain the facts and opinions needed to answer the research question.

Comparative methods of analysis will be used to identify and compare emerging themes, thereby enhancing a more comprehensive and coherent understanding of the data collected (Lincoln & Guba, 1985:335). Mouton (2001: 108) states that the aim of data analysis is to identify the main categories or patterns in the data and suggests that data should be "broken up" into themes, patterns, trends or relationships, which would be manageable for later interpretation by the researcher. Leedy and Ormrod (2001: 153) give a similar description of data analysis by stating that it involves the reduction and interpretation of data. The fundamental task during data analysis is to identify common patterns or central themes in people's descriptions of their experiences (Leedy & Ormrod, 2001:153).

## **1.8 CLARIFICATION OF TERMS AND CONCEPTS**

- Poor performance

In this study, poor performance refers to scores below 50%.

- **Causative factors**  
Causative factors, in this study, are the factors that respondents will identify as having a negative influence on the pass rates of Grade 12 science and mathematics.
- **School syllabus**  
A plan of what learners need to know in a certain subject, the topics that need to be understood and desired levels of achievement for particular grades as set out by the Department of Education. The National Curriculum Statement specifies the minimum standards of knowledge and skills to be achieved at each grade and sets high, achievable standards in all subjects (Department of Education, 2003: 3).
- **Gaps in learning**  
Gaps in learning, in this study, refer to subject matter that has been taught to learners, but which learners have not completely understood.
- **Further Education and Training**  
Further Education and Training (FET) is one of the sectors or bands of Education in South Africa which includes Grades 10 to 12. It means all learning and training programmes leading to qualifications from levels 2 to 4 of the National Qualifications Framework as contemplated in the South African Qualifications Authority Act, 1995 (Act 58 of 1995), which levels are above general education but below higher education (Republic of South Africa, 1998: 4).
- **National Qualifications Framework**  
The National Qualifications Framework (NQF) is a framework that integrates education and training at all levels of South African education (OECD, 2008: 20).

## **1.9 OUTLINE OF THE STUDY**

- Chapter one will be a general overview. The first section will be a general introductory phase discussing mathematics and science education. The nature of the research problem will be illustrated. The aims, delimitations, ethical considerations, and clarification of terms will be incorporated into this section.
- Chapter two will provide the general theoretical framework. It will entail an in-depth exploration of literature on theories associated with science and

mathematics education. Variables regarded as causative factors of low pass rates in science and mathematics education will be explored

- Chapter three will discuss policies and legislative framework on teaching and learning.
- Chapter four will highlight the paradigmatic approaches, methodology, and data collection instruments.
- Chapter five will report on the findings of the survey by means of in-depth analysis of empirical findings.
- Chapter six will draw together the findings into conclusions, and recommendations will be proposed.

The following chapter is an in-depth exploration of the relevant literature reviewed in terms of the topic of this study.

## CHAPTER 2

### GENERAL THEORETICAL FRAMEWORK

#### 2.1 INTRODUCTION

Mathematics and science shape an important part of people's daily lives. South African people rapidly discover themselves on a technological road where mathematical, scientific and creative thinking, as well as problem-solving skills, take centre stage (Maqsdud & Khaliq, 1991:377). The South African White Paper on science and technology (1996: 10) states that science is considered to be among the requirements for creating wealth, and improving the quality of life. It is certainly true that a strong mathematical background is necessary for many career and job opportunities in the increasingly technological society of the present time, but unfortunately many potential university students of mathematics restrict their education and career options by discontinuing their mathematical training in their high schools. Some of those who do continue to study mathematics in high schools and university departments do not demonstrate a satisfactory achievement in mathematics (Maqsdud & Khaliq, 1991:377).

Increasing the number of science-orientated graduates to meet the technological challenges of the 21st century is vital for economic sustainability and growth in South Africa (Kopolo, 2009:5). Kopolo also sees a need to address diverse knowledge and skills requirements for South Africa. These are needs that are relevant for the different occupational or professional categories. She further states that this shift towards knowledge and skills production is, according urgently required in order for South Africa to become globally competitive enough to be able to address the socio-economic development within its boundaries.

According to Steen (1989: 19), mathematics does not only empower people with the capacity to control their lives, but also provides science with a firm foundation for effective theories and guarantees society a vigorous economy. He further states that at the most basic level, mathematics is a requirement for science, computer technology and engineering courses. Seen from a social perspective, mathematical competence is an essential component in preparing numerate citizens for employment, and it is needed to ensure the continued production of highly skilled persons required by industry, science and technology.

## **2.2 SCIENCE AND MATHEMATICS IN SCHOOLS**

Fricke (2008:65) asserts that South Africa has a shortage of learners matriculating with mathematics and science marks that qualify them for further study in Science, Technology, Engineering and Maths (STEM). According to him, international benchmark studies confirm that school mathematics and science in South Africa are weak and suffer from systemic problems. Reddy (2005: 125) states that most South African citizens meet mathematics and science knowledge for the first and last time in the schooling system, and that competency in these gateway subjects at a school level, opens up opportunities for empowerment through an understanding of common technologies, and provides better access to tertiary education and higher skilled jobs and livelihoods. She has also observed that by most performance indicators, South Africa is performing poorly in mathematics and science. She also is of the opinion that although South Africa has many policies and programmes to improve the state of mathematics and science education, the ultimate indicator of the success is the performance by learners.

Howie (2003: 1) gives a similar report when he writes; “International measures indicate that South African learners are performing poorly in science. For example, of the 38 and 50 countries that participated in the Trends in Mathematics and Science Study (TIMSS) in 2001 and 2003, respectively, some of which are developing countries, South African learners came last in Mathematics and Science”. Maree, Pretorius and Eiselen (2003: 400) believe that the failure rate in science and mathematics at school remains unacceptably high.

The Centre for Development and Enterprise (CDE) released a report in 2004 on the state of mathematics and science in South Africa. The report covers three years of research, analysis and discussions with over 1000 experts. The main conclusion was that despite efforts from the government as well as the private sector, the throughput of students with mathematics and science is far too low to provide the country with the necessary skilled workers to build the economy (Kopolo, 2009: 13). Howie (2003: 1) has reported that International measures also indicate that South African learners are performing poorly in science. She gives an account of South Africa's performance in the Trends in Mathematics and Science Study (TIMSS) in 2001 and 2003 respectively, in which out of the 38 and 50 countries, some of which are

developing countries that participated, South African learners came last in Mathematics and Science,

### **2.3 CAUSATIVE FACTORS OF LOW PASS RATES IN SCIENCE AND MATHEMATICS**

Howie (2005: 124) has reported on a variety of factors that have been found to influence achievement in schools. She lists textbooks, teacher quality, and time as key factors that emerge from school effectiveness research. Leadership, organisation, and management, she says, are also identified as important factors by school effectiveness researchers, whilst school improvement researchers have concentrated on decision-making within school hierarchy and communication. Class size, she reports, seems to have a minor effect on achievement. She also gives details of more recent findings in school effectiveness studies, which show that school-level factors influence achievement far less than do factors at the class level. Other influential factors she found, are teacher expertise and competence, strong leadership, clear organisation of the school day and the learning programme (time and opportunity), and community and parental involvement in school governance (Howie, 2005: 125).

Maqsd and Khaliq (1991: 377) attribute the poor performance of students of mathematics in South African secondary high schools to; a shortage of mathematics teachers, a high proportion of unqualified teachers, the poor standard of textbooks, and the negative attitude of the general public and students towards mathematics. Kriek and Grayson (2009: 185) explain that there are several complex problems that contribute to learners' poor performance in science and mathematics. These include poverty, resources, learning cultures, infrastructure of schools and low teacher qualifications. Legotlo, Maaga and Sebego (2002: 114) suggest that the socio-economic background of learners may have some influence on learners' performance. They report that learners from low socio-economic backgrounds may be undernourished and hungry when attending school. The consequence thereof was that these learners learn little in school.

It is believed that South Africa's performance at TIMSS may be attributed to a number of factors that may be found at both school and classroom level. There are approximately 12 million pupils at about 28,000 schools in South Africa (Howie, 2005:



122). However, the majority of these pupils attend schools where conditions are less than optimal for teaching and learning. Many teachers are also not qualified to teach their subjects. Furthermore, in general, many teachers in government schools are faced with large classes, especially in schools that previously catered for African pupils only. Moreover, less than half of the pupils writing the national Grade 12 final examinations pass mathematics (Howie, 2005: 123).

It has been discovered that school-level factors influence achievement far less than do factors at class level. Classroom-level has “maybe two or three times the influence on student achievement than the school level does”. Classroom-level factors associated with performance in science factors affecting performance include time taken on tasks, homework, teacher knowledge, textbook provision, libraries, teachers’ experience and class size. In addition, laboratories are seen as important for effective schooling (Howie, 2005: 124).

Taylor, Pressley and Pearson (2000: 60) argue that factors that result in effective schools consist of two components; namely instructional factors on a classroom-level and organisational factors on a school-level, both of which are equally important. They hold an idea that the situation in developed and developing countries may well be different in relation to outcomes in research at the school level, and in which factors influence student achievement. They report that one important difference is that resources at schools are especially important in developing countries as there is often a shortage of textbooks and instructional materials, laboratory equipment, and multi-media equipment, and basic stationery requirements often go unmet. This, they say, is in contrast to most developed countries where these are taken for granted. Other influential factors they found are teacher expertise and competence, strong leadership, clear organisation of the school day and the learning programme (time and opportunity), and community and parental involvement in school governance.

Poor socio-economic background of learners, poor incentive to study at home, lack of appropriate learner support materials, general poverty of school environment, general poor quality of teachers and teaching (including poor subject knowledge and poor motivation), language of instruction (often not the same as learners' mother tongue), and an inadequate study orientation, are believed to be causative factors of low success rates of learners, as indicated by Maree, Aldous, Hattingh, Swanepoel

and van der Linde (2006: 230). Qhobela and Rollnick (2010: 6) give an account of high schools that offer science subjects at both junior and senior secondary levels as lacking resources such as laboratories, equipment and chemicals. They report that most schools are characterised by empty libraries, overcrowded classrooms and laboratories, and lack of other teaching and learning facilities such as computers and teaching aids. They are of the opinion that this is coupled with a severe shortage of science teachers.

## **2.4 LANGUAGE AS A BARRIER TO LEARNING**

Austin and Howson (1979: 164) argue that the most obvious problem encountered in developing countries is that caused by the learner having to learn mathematics in a language other than his or mother tongue. Atwater (1996: 828) states that conventional science teachers view science as being independent of mind or social context. This could be one of the reasons why language has not been considered important until lately. According to Henderson & Wellington (1998: 35) for many learners, the greatest barrier to learning science is language. The problem is that like many other African countries, South Africa has developed science curricula and content upon Western trends, and teaches science mainly in English or Afrikaans. Kasule and Mapolelo (2005: 605) state that teaching school mathematics in a big multi-lingual classroom and in a language, which is not for those in the classroom. Anyone's mother tongue is a professional challenge for teachers in several ways. Language, they say, may be a source of learning difficulties in mathematics because each learner's mother tongue is the key to the world and a means of alleviating the abstract nature of classroom learning events.

## **2.5 THE TEACHER**

Morar (2002: 274) observes that in South Africa, mathematics and science education has been identified as a critical area for reform in schools because there are at present a large number of under-qualified and inexperienced teachers who lack both the subject knowledge and appropriate classroom teaching and management skills. Taylor and Vinjevold (1999: 139) contend that teachers' poor grasp of the knowledge structure of mathematics, science and geography, acts as a major inhibition to teaching and learning of these subjects. They are of the opinion that strengthening science teachers' content knowledge should be an essential component of any professional development programme.

Mumba, Rollnick and White (2002:153) argue that mathematics and science educators should have knowledge and understanding regarding the foundation of the teaching of these subjects in both the intermediate and senior phases at schools. Adler and Reed (2002:25) are of the opinion that the issue of how to integrate further learning of the subject with learning about how students in school acquire subject knowledge, is of greater importance than merely possessing content knowledge. They suggest that teachers need to learn “subject knowledge for teaching”.

Legari (2004: 11) says most mathematics and science educators are not qualified to teach these subjects. He reports that out of 84% of science educators who were found to be professionally qualified, only 42% were qualified in science. An estimated 8000 mathematics and 8200 science educators needed to be targeted for in-service training to address the lack of subject knowledge. He says that the lack of proper content knowledge in particular, leaves teachers poorly prepared to teach their learners. He also states that in the past few years, it was found that over 45% of general science teachers and almost 40% of physical science teachers had less than two years experience teaching their subjects.

The new curriculum is based on a National Curriculum Statement (NCS) which “aims to develop a high level of knowledge and skills in learners” (Department of Education, 2003: 3). Isaac (2009: 1) feels that the new curriculum has high expectations of South African mathematics learners. She states that embedded in the development of knowledge in learners would be a high level of knowledge in educators. She reports that the NCS document also spells out the type of teacher that is envisaged. The teacher, she says, is expected to be qualified, competent and a specialist in his or her field. She argues that in order for the teacher to be competent and skilful in his or her learning area, he or she needs certain knowledge which she believes includes content knowledge.

Karasira (2004: 6) says that if educational systems establish new expectations for learners, teachers, and school communities for which some educators may not be prepared, it is important to prepare educators to meet these new expectations. He goes further by stating that in order to achieve this task, it is recognised that ongoing professional development is the key to keeping teachers abreast of current issues in education and enable them to cope with new educational expectations.

## **2.6 PARENTAL INVOLVEMENT**

Omogbe (2010: 176) points out that parental educational level is known as a factor positively related to children's academic achievement. He goes further by saying the family is the main factor influencing the lives and outcomes of students and the educational level of parents is a powerful factor influencing children's academic success. He states that it has been established that generally, the educational level of parents is greatly connected to the educational attainment of their children. Omogbe suggests that parents play an immense and significant role in the academic performance of their children. Educated parents would have increased emphasis on educational excellence. He points out that attitudes of children, given encouragement by their parents, particularly the educated ones, are better (Omogbe, 2010: 176).

There are different assumptions about lack of support from parents, especially in the rural schools. Some of the reasons are that parents lack confidence of being actively involved in their children's education, since they themselves did not receive proper formal education (Legari, 2004: 13).

## **2.7 CURRICULUM CHANGE**

According to Glatthorn, Boshee and Whitehead (2004:256), a high level of curriculum implementation can be expected if the curriculum changes are not unduly complex and are clearly explained to teachers, if quality materials supporting the new curriculum are made available to teachers, and if administrators take the necessary steps to prevent and respond to the problem of "overload" when teachers feel overwhelmed in implementing the curriculum. According to Rogan (2000:121), "lack of space, learning support material, competent educators in various learning areas, long-term support systems, inadequate in-service training and lack of shared vision, and commitment are critical factors that impact negatively on practical implementation." He points out that the new curriculum brought in greater amounts of anxiety and uncertainty as teachers struggled with the understanding and application of the new concepts.

Kelly (2004: 126) reports on how Curriculum 2005 was revised in 2001 due to challenges faced by the new curriculum. The Revised National Curriculum Statement (RNCS) was then introduced in the senior phase of the general education and

training (GET) schools. Kelly states that schools experienced severe shortage of resources such as staff shortage, textbooks, furniture and classrooms. These unfavourable conditions impacted negatively on the implementation of the new curriculum. According to Kelly (2004: 126), “each new curriculum requires extra time for teachers to prepare lessons and materials, to become familiar with the new concepts and skills to be taught, to prepare or administer new tests, and to gather reference resources.”

Hobden (2005: 202) gives a similar account of the new curriculum by saying that the new curriculum demanded schools to be highly resourced in terms of equipment, material resources, and infrastructure. Hobden is of the opinion that “the Department of Education dynamically pursued policy development, while giving insufficient attention to how the under-resourced provincial departments and schools, and teachers were to cope with the difficult task of implementing a radically and highly technical curriculum change, with the budgetary constraints experienced by provincial departments, the poor state of many schools, and the poor training of many teachers.

Aubusson and Watson (1999: 603) maintain that curricula and associated teaching methods often have difficulties when implemented across the nation. They say such difficulties may be exacerbated when the curricula and teaching approaches are imported or transferred from developed to developing countries. This, they state, may be a particular issue in the public schools in developing countries, because those schools are not well-resourced. South Africa's current curriculum policies, in their opinion, make new demands on schools and teachers, based on ideas that have been largely developed overseas.

Aubusson and Watson (1999: 604) go further by maintaining that importing of curriculum is likely to result in a curriculum that poorly fits the current educational environment in developing countries. They feel that communities in the rural parts of South Africa may be further isolated from their children's learning of science since the curriculum may sound foreign to them (because it tends to be oriented to urban life and experiences). They also say that parents may be unable to link what their children learn in schools with the experiences in their daily lives.

### 2.7.1 OBE in the classroom

Johnson, *et al.* (2003: 85) claims that the introduction of OBE in South Africa has placed a strain on all teachers as the education system meanders its way towards the shifting goal posts of the new curriculum. She states that science teachers have been under more strain than others, simply because science is generally viewed as a practical subject. She goes on by stating that the focus on outcomes means science teachers have had to weigh up which practical skills they should seek to develop in their learners, a decision complicated by the fact that the majority of schools have large classes and few resources to teach science.

McNeir (1993:1) affirms that the South African education system has been undergoing extensive restructuring since the advent of democracy. Coinciding with the formation of democracy in South Africa in 1994, an Outcomes-Based Education system was formulated. Introduced in 1998 and amended in 2001, this system asserts that all learners have the ability to succeed, and focuses on the acquisition of knowledge, skills, values, and attitudes, unlike the traditional practice that was based on content mastery only. According to this paradigm, teachers are expected to introduce real-life mathematics into classrooms, and help learners acquire skills that will prepare them to become life-long learners and critical thinkers. .

Over the last few decades, a plethora of national plans have originated in developing countries to promote educational provision for economic development. South Africa too, as a result of the new political dispensation of 1994, has followed a similar trend and the problem-centred approach in mathematics has received attention as an alternative to the more traditional approach in South Africa. The latter is associated with rote learning, learning without the necessary insight, a lack of creativity, a tendency to be too teacher-orientated and a lack of learner activity (Maree, Aldous, Hattingh, Swanepoel & Van der Linde, 2006: 230).

Ramnarain (2003:33) argues that disadvantaged learners from seriously impoverished learning environments are lacking in the necessary informal mathematical knowledge prescribed [the problem-centred approach to teaching and learning mathematics] to develop their own strategies for solving non-routine mathematical problems. Fricke (2008: 72) states that the new curriculum introduced by the Department of Education requires extra content knowledge to be mastered,

as well as bringing with it a need to re-structure school timetables. Seefeldt (1999: 125) believes that resources are needed in order to realistically engage in mathematical problem-solving.

## **2.8 RESOURCES**

Legari (2004:1) states that in South Africa, different research areas in education have established that most schools are under resourced, especially when looking at physical science as an area for teaching and learning. She says that the majority of schools that offer mathematics and science have a serious problem with regard to facilities such as laboratories and equipment to promote effective teaching.

In South Africa, many teachers are expected to deal with the implementation of the new curriculum and also the lack or poor distribution of resources at their schools. Resource issues are critical when implementing a new curriculum. Many South African schools are under- resourced and even the infrastructure in some cases is bad, while some schools are highly resourced with good infrastructure. Teachers are expected to implement the new curriculum, whilst working under strained conditions. The presence or lack of resources play a large part in determining the balance of advantage between different educational development strategies, and place different boundaries around what is possible and sustainable. Therefore, the way in which teachers engage with learning programmes is constrained by the availability of resources (James, 2000: 6).

## **2.9 CLASS SIZE.**

A larger class size is sometimes considered to be a major stumbling block to the practising of regular group activity and learner-centred science (Caillods, 1997 cited in Legari, 2004: 15). According to Naidoo and Savage (1998: 122), most African countries have a reality of large and poorly resourced classes. Under such circumstances, the burning question that Naidoo and Savage pose is to "whether there is a relationship between large classes and outcome measures such as pupil achievement and teacher satisfaction?" Legari (2004: 15) states that having a small number of learners does not necessarily mean that the teaching process is of high quality; conversely, a large number does not necessarily mean that teaching is ineffective.

## 2.10 TEACHER SUPPORT MECHANISMS

A 1995 National Teacher Audit showed that South Africa's teachers are in need of in-service training. As a result, the government of South Africa, with the support of Non-Government Organisations, is in the process of trying to attain measurable gains by upgrading teachers through in-service strategies. Through such programmes, more focus is laid on teacher capacity development and related in-servicing (INSET) programmes; curriculum reform and outcomes based activities; equity of access and quality of instruction; and transformation of management capacity for expediting open learning environments. They also provide teachers with skills of working under different conditions (Legari, 2004: 28).

## 2.11 TEACHING AND LEARNING

South Africa is faced with the unequal distribution of its human resources, especially in science, engineering and technology (SET), which has critical implications for human resource development, education and training policy in general, and SET education in particular. This inequity in SET participation has created new challenges with regard to SET interventions that would empower and enable marginalised communities to make informed decisions about their future. One of the greater challenges in addressing the SET needs of the country is the teaching and learning of science and mathematics at the secondary school level (Hartleya, Treagustb & Ogunniyic, 2008: 596).

Isaac (2009:16) distinguishes between three categories of content knowledge that she feels teachers need to have, namely:

- **Subject matter content knowledge.** This refers to the knowledge that the teacher possesses about his or her subject. This goes beyond the knowledge of facts and concepts pertaining to a particular subject and encompasses knowledge about why concepts and topics are important to a subject, which topics are central and which are peripheral.
- **Pedagogical content knowledge.** This goes beyond the knowledge of a particular subject and incorporates knowledge on how to teach the particular subject. This includes knowledge of topics most often taught in a particular subject, the most important and appropriate examples that are used and the most meaningful forms of representations used. All these come from



experience and practice. Pedagogical content knowledge also includes knowledge about what makes a particular topic easy or difficult for pupils to understand, the common misconceptions that pupils may have on a particular topic and the strategies on how to deal with these issues.

- **Curricular knowledge.** This refers to the teacher's knowledge firstly about his or her own subject matter, that is, knowledge about the content taught in preceding years and the content to be taught in years that follow. In this way, the teacher can adequately teach pupils present content as he or she is aware of what they already know and he or she is also aware of how the current topic will be extended in future years. Secondly, curricular knowledge also refers to knowledge about other subjects and how this links to knowledge in a particular subject and field. In this way, the teacher can relate what the pupil is learning in one subject to what is being taught in another subject, and this makes learning more meaningful and relevant.

Isaac (2009:19) contends that what constitutes subject knowledge for teaching and how it is best to acquire this, is a challenge that faces teacher education everywhere. She states that subject knowledge for teaching is a very important aspect of the preparation that a teacher requires in order to be productive in the classroom. She continues by saying that a consideration of teachers' subject knowledge cannot be isolated from its use in order to revitalise teacher education and classroom practice. She is of the opinion that it is important to upgrade the teacher's subject matter knowledge. She says that only if a teacher can engage with his or her subject matter in a meaningful way can he or she hope to impart this in a meaningful way to learners. Isaac points out that presently South Africa is faced with the challenge to improve the content knowledge of teachers. There are, she says, a number of reasons for this, and the crucial one being "that knowledge of subject matter for teaching is of primary importance, for without this, teachers would not be able to engage their learners in high-level conceptual thinking" (Isaac, 2009:19).

### **2.11.1 Approaches to teaching**

Jacobs, Gawe and Vakalisa (2002:211) state that "teaching method refers to the manner in which the teacher imparts knowledge to learners." A teacher needs to employ various strategies when delivering instruction in order to meet learners'

varying needs. Arguing along similar lines, Price and Nelson (2007: 53) maintain that “using various strategies keeps students engaged, making them more likely to learn, retain and process the information presented.” In a learner-centred approach, various methods could be used to stimulate learners’ interest in the learning activities, for example, grouping learners for discussion, question and answer method, role plays, drama, brainstorming and debates. In grouping learners, mixed-ability groups should be formed so that learners can learn from one another by sharing views and discussing topics of common interest. Kyriacou (1998:43) states “that one of the advantages of having mixed-ability groups is to allow pupils from different backgrounds to mix socially and academically.” Another teaching method that would promote active participation by learners is the question–and–answer method. James (1998:87) states that “asking students questions in the course of teaching is a vital tool in every teacher’s kit of teaching methods, at the same time it is a form of on-going assessment by which the teacher actively seeks information about students”.

Hobden (2005: 303) states that physical science teachers have a responsibility to provide a learning environment in which learners can develop the desired skills and understanding set out in the curricula. He goes on by saying it is generally accepted within the science education literature that understanding cannot simply be transmitted directly from teacher to learner but that it requires the learner to get involved in his or her own learning and actively make sense of new information. Consequently, he says teachers need to plan educative experiences that provide students with opportunities to become involved and to construct their understanding

To achieve this, in Hobden’s opinion, there are many different types of activities possible within the school environment, such as project work, practical investigations, debates, quizzes, explaining of phenomena through writing and discussion, gathering and interpreting evidence, cooperative group problem-solving and so forth. Depending on a number of factors such as available resources, learners may, he believes, encounter a limited set or a broad range of activities in their physical science lessons. However, according to him, in spite of the best intentions of teachers, they are often constrained by external factors in the activities they plan for learners. One of the more obvious external influences on practice is the assessment system. Given the high-stakes assessment practices associated with the current

physical science curriculum, it is to be expected that they will be a significant factor in determining what happens in the classroom (Hobden, 2005: 303).

### **2.11.2 Learning styles**

Visser, McChlery and Vreken (2006: 97) maintain that a learning style refers to a person's preferred approach to learning. They claim that students learn in different ways and the approach they prefer may be an important determinant in their academic performance. Students' learning context is a broad term which encompasses a variety of student-related variables such as learning styles on the one hand, and variables which educators can control on the other. Educators need to adopt approaches to teaching and assessment that enable students with different learning styles to learn effectively and to create a suitable mix of different learning opportunities to ensure that the largest possible number of learners can learn effectively. Identifying individual students' learning characteristics may help educators to improve their course design and choose helpful and appropriate learning outcomes, modes of delivery and assessment.

Experimental studies have proved that some of students' worse results in certain subjects are caused not necessarily by the difficulty generated by the internal structure of knowledge, but mostly by difficulty in adapting to one or other of the methods the teacher uses (Nicola, 1992: 19). In modern didactics, a learning method is understood as a certain way of acting, which tends to place the student in a more or less conducted learning situation that comes close, almost to identification, to one of scientific research, of following and discovering the truth, and connecting it to practical aspects from life (Ionescu & Radu, 2001: 7).

Galton and Eggleston (1979: 75) indicate that research has shown that teaching and learning styles have a significant effect on the quality of instruction. They state that research on the role of teachers and students in the teaching and learning of mathematics and science has become an area of research focus in science and mathematics education in the past decade. According to them, studies have indicated that teachers need to equip themselves with more flexible approaches in the teaching of mathematics and science.

## **2.12 ASSESSMENT**

Assessment plays an integral part in curriculum implementation as it helps to diagnose learning problems, track learner progress, provide feedback to learners, and provide evidence of learners' level of achievement. According to Kelly (2004:126), "it is of the essence of good teaching that one should constantly be attempting to gauge the levels of pupils' learning in order to lead them to further development."

Assessment in the new curriculum plays a vital role in informing the learner and the teacher about the learner's progress. When learners are assessed, a variety of forms can be used. The Department of Education (1998:12) states that "the performance should be measured against the specific outcomes, using a wide range of methods, tools and techniques such as informal monitoring by observation, formal use of appropriate standardised tests, interviewing, self-assessment, peer assessment, project work and assignments." According to the National Education Policy Act (Act 27 of 1996), educators should understand that assessment is an essential feature of the teaching and learning process.

## **2.13 CONCLUSION**

This chapter was a presentation of the review of the literature relating to science and mathematics education in schools. An analysis of causative factors of low pass rates in science and mathematics was presented. From the different factors identified, several of the factors were examined. The review of literature indicates that addressing causative factors of low pass rates is crucial in improving the quality of science and mathematics education in South Africa. The factors identified in this chapter are regarded as barriers to learning. It is important to note that different learners experience different barriers to learning. This chapter focused on the teacher, the curriculum, resources, and teaching and learning. The researcher focused on the knowledge and skills teachers need to possess in order to effectively teach science and mathematics at high school level, as well as the teaching and learning, and assessment process.

The following chapter focuses on the overview of the South African regulatory framework in the form of legislation and policies that impact on the topic of the study.



## **CHAPTER THREE**

### **CURRICULUM REFORM AND LEGISLATIVE FRAMEWORK ON TEACHING AND LEARNING**

#### **3.1 INTRODUCTION**

In 1953, the National Party government brought education for black South Africans under central government control and systematically reinforced decades of racially and geographically segregated and financially neglected schooling, despite increasing enrolments and growing skills shortages. The struggle against Apartheid was reignited during the 1970s by secondary school students, forcing the government into a series of political and economic reforms that, however, were too little and too late. In the period of negotiations between the African National Congress and the National Party government from 1990 to 1994, the economy stagnated and education continued to deteriorate. The newly elected Government of National Unity was faced, in 1994, with the mammoth task of completely restructuring and rebuilding the education system and redressing the inequities of the past (Organisation for economic co-operation and development (OECD, 2008: 36).

Since 1994, the government has worked to transform all facets of the education system. The fragmented and racially duplicated institutions of the Apartheid era have been replaced by a single national system including nine provincial sub-systems. Consistent and persistent efforts are being made to make education structurally accessible to all learners who were previously denied, or had limited access to it, and thus realise the ideal of nine years of compulsory schooling. Marginalised or vulnerable groups have received particular attention in the form of inclusive education programmes and pro-poor funding policies (Organisation for economic co-operation and development (OECD), 2008: 36).

Government policy on learners with special needs emphasises the mainstreaming of learners with mild learning disabilities into ordinary schools; school fee exemptions and, most recently, “no fee” schools have assisted indigent learners into schools (Organisation for economic co-operation and development (OECD), 2008: 37).

The new democratic government has concentrated on creating a single unified national system of education, increasing access (especially to previously marginalised groups and the poor), decentralising school governance, revamping the curriculum, rationalising and reforming further and higher education (OECD, 2008: 19). Adler (2002: 2) asserts that the South African education system has been occupied by the huge test of transformation from a deeply unequal and racially segregated system and curriculum to an integrated system and a new vision for the education and development of all South Africa's learners. She argues that the challenge has been at every level of the system, including the structure and functioning of national and provincial departments, districts, schools, and classrooms, as well as the conception and implementation of new policies for curriculum, teacher education, and language-in-education, and for overall funding of education as a public good.

Since 1994, the Department of Education has developed policies and legislations such as the South African Schools Act, 1996 (Act 84 of 1996), Curriculum 2005 and whole school evaluation which, aimed at transforming the education system. The emphasis of these policies and legislations is on achieving equitable access to education, improving the quality of provision of education, and encouraging the involvement of different stakeholders (especially learners and parents) in the running of school matters (Legari, 2004: 10).

Isaac (2009: 34) states that with the institution of the first fully democratically elected government in 1994, a forceful endeavour was mounted to transform South African schooling. She points out that the new government adopted the vision of the international progressive agenda for systematic change and established a number of key policy instruments in terms of constitutional rights, qualifications, school governance, school funding, language, teacher management and alignment of qualifications, curriculum, assessment and gender. According to her, together these documents represented an impressively coherent vision for the fundamental transformation of the South African schooling system. Isaac is of the opinion that possibly one of the most important reforms to take in terms of its immediate impact on the education of young adolescents was the introduction of a new curriculum. The curriculum, she says, builds on the vision and values of the Constitution of the RSA, 1996 (Act 108 of 1996). These principles, according to Isaac, include social justice, a

healthy environment, and human rights and inclusivity, which reflect the principles and practices of social justice and respect for the environment and human rights, as defined in the Constitution, 1996. Isaac also says that the curriculum attempts to be sensitive to issues of poverty, inequality, race, gender, age, disability and such challenges as Human Immunodeficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS).

In 1996, the Department of Arts, Culture, Science and Technology (DACST) reported that new approaches to education and training needed to be developed in order to equip researchers to work more effectively in an innovative society. The Department said that new curricula and training programmes that were comprehensive, holistic and flexible, rather than narrowly discipline-based, were required. According to the Department, 'education and training in an innovative society should not trap people within constraining specialities, but enable them to participate and adopt a problem-solving approach to social and economic issues within and across discipline boundaries' (DACST, 1996: 10).

In line with the Constitution, 1996, and through the National Education Policy (Act 27 of 1996), national and provincial governments share responsibility for all education except tertiary education, which is the preserve of national government. Education in South Africa can be broken down into the following sectors or bands:

- Early Childhood Development (ECD).
- General Education and Training (GET), consisting of:
  - ✓ Grade R to Grades 1 to 3 (the Foundation Phase).
  - ✓ Grades 4 to 6 (the Intermediate Phase).
  - ✓ Grades 7 to 9 (the Senior Phase).
- Further Education and Training (FET), including Grades 10 to 12.
- Adult Basic Education and Training (ABET).
- Special Needs Education (SNE).
- Higher Education (HE).



Schooling is compulsory for all children from the year in which they turn 7 to the end of the year in which they turn 15 (or the end of Grade 9, whichever comes first). A National Qualifications Framework (NQF) integrates education and training at all levels (OECD, 2008: 20).

### **3.2 POLICY AND LEGISLATIVE FRAMEWORK**

The Constitution, 1996 requires education to be transformed and democratised in accordance with the values of human dignity, equality, human rights and freedom, non-racism and non-sexism, and guarantees the right to basic education for all learners, including adult basic education. The Constitution, 1996, determines that the three spheres of government (national, provincial and local), which are “distinctive, interdependent and interrelated”, should function together co-operatively; and, since South Africa has no tradition of municipal responsibility for education, it provides that the national sphere has exclusive legislative responsibility for tertiary education and shares concurrent responsibility with the provincial spheres for all other levels of education. Through the National Education Policy (Act 27 of 1996), the Minister of Education, working with the provinces, sets the political agenda and determines the national norms and standards for education planning, provision, governance, monitoring and evaluation. The nine provincial Departments of Education are responsible for implementing education policy and programmes, which are aligned with the national goals (OECD, 2008: 39).

### **3.3 CURRICULUM REFORM**

In 1995, the South African government began the process of developing a new curriculum for the school system. There were two imperatives for this. First, the scale of change in the world, the growth and development of knowledge and technology, and the demands of the twenty-first century, required learners to be exposed to different and higher level skills and knowledge than those required by the existing South African curricula. Secondly, South Africa had changed. The curricula for schools therefore required revision to reflect new values and principles, especially those of the Constitution, 1996 (Department of Education, 2008: 2).

The Organisation for Economic Co-operation and Development (OECD, 2008: 80) state that overturning the curriculum of the Apartheid government and replacing it with one that supported a human rights-based education was an immediate systemic

challenge for the post-Apartheid government. It gives an account of the first reform, following the 1994 elections, by saying that it was to rationalise and consolidate the syllabi of the hitherto existing racially segregated education departments and to remove overtly racist, sexist and offensive language. These cosmetic changes, according to the organisation, were an interim measure, while a new national curriculum, which came to be known as Curriculum 2005 (C2005) was being constructed. C2005, was launched in March 1997 in South Africa and was implemented in phases from the beginning of 1998. Both the content and the teaching of the existing curriculum were overhauled and brought into line with the values of the Constitution, 1996.

Drawing from international curriculum developments (particularly in New Zealand and Australia), C2005 was grounded in outcomes-based education (OBE) principles. “Subjects” were replaced with “learning areas”, each of which had “range statements” that, in turn, aimed at “outcomes”. The learning areas reframed traditional subject disciplines into an integrated knowledge system. The curriculum was supposed to integrate education and training, incorporate a view of learning which rejected rigid divisions between academic and applied knowledge, theory and practice, and knowledge and skills. It was supposed to foster learning which encompassed a culture of human rights, multilingualism and multi-culturalism and sensitivity to the values of reconciliation and nation building. The content of lessons was not prescribed and the new teaching strategies that accompanied the curriculum were “learner-centred”. The new curriculum was a novel system for all educators, black or white, no matter where they had been trained (OECD, 2008: 80).

The first version of the new curriculum for the General Education Band, known as Curriculum 2005, was introduced into the Foundation Phase in 1997. While there was much to commend the curriculum, the concerns of teachers led to a review of the Curriculum in 1999 (Department of Education, 2003: 1). According to the OECD (2008: 80), almost immediately after its introduction, Curriculum 2005 raised controversy. They give an account of Curriculum 2005 as being criticised for being too elaborate in that it involved new and unnecessarily complex terminology and depended on poorly trained and already overworked educators for its implementation. The curriculum, they say, was also heavily reliant on resources, textbooks and even

classroom space, and many poor schools were already struggling with few and outdated textbooks, and minimal resources.

Educator training under Apartheid had emphasised rote learning, authoritarian teaching practices (enforced through corporal punishment), and behaviourist pedagogy, leaving most of the profession unprepared for the constructivist teaching approaches of the new curriculum (OECD, 2008: 80). Educators, as the organisation informs, were inducted into the new system, using a cascade model of training, which proved problematic as the complexity of the curriculum was watered down with each level of training. While historically advantaged schools had greater success at implementing the curriculum, disadvantaged schools floundered, potentially widening the gaps between schools (OECD, 2008: 81).

The OECD (OECD, 2008:81) reports that a Ministerial Committee that was appointed to review Curriculum 2005 found that its implementation had been confounded by a skewed curriculum structure and design; lack of alignment between curriculum and assessment policy; inadequate orientation, training and development of educators; learning support materials that were variable in quality, often unavailable and not sufficiently used in classrooms; policy overload and limited transfer of learning into classrooms; shortages of personnel and resources to implement and support C2005; and inadequate recognition of the curriculum as the core business of education departments.

The report, according to OECD, recommend a number of practical adaptations. The resulting change has since produced a Revised National Curriculum Statement which, written in plain language, gives more emphasis to basic skills, content knowledge and a logical progression from one grade to the next. Along with the values enshrined in the Constitution, it emphasises communication, participation, human rights, multi-lingualism, history, cultural diversity, the need for educators to act as role models and that every South African is able to read, write, count and think. Thus, they say, it combines a learner-centred curriculum requiring critical thought and democratic practice, with an appreciation of the importance of content and support for educators (OECD, 2008: 81).

The review of Curriculum 2005 provides the basis for the development of the National Curriculum Statement for General Education and Training (Grades R-9) and

the National Curriculum Statement for Grades 10-12 (Department of Education, 2003: 1). Chelin (2003: 2) writes that the South African Department of Education embarked on a process of curriculum review in 1995 and the first version of Curriculum 2005 was published in 1997. In response to widespread criticism of the new South African curriculum, she says that a supporting policy document (The Revised National Curriculum Statement Grades R-9 Policy) was drafted in 2001, which was opened for public comment, and published in 2002. This supporting document, whilst still upholding the underlying principles of Curriculum 2005, outlines more practicable ways of implementing Curriculum 2005.

According to Chelin (2003: 2), the focus of South African science education in the previous curriculum was on closed problem solving, transmission of scientific knowledge and demonstrative practical activity that served to verify, rather than question theory. Curriculum 2005, she says, like the previous curriculum, still calls for learners to construct a broad understanding of science knowledge, but the nature of science is now given equal status to the body of science knowledge. She says that whereas it was once common for the school curriculum to present scientific discovery as the inevitable outcome of the 'correct' application of a rigorous, objective, disinterested, value free and all powerful scientific method, many contemporary science curricula are now beginning to realise that science and technology are human endeavours that influence, and are influenced by the socio-cultural context in which they are located.

### **3.4 THE NATIONAL CURRICULUM STATEMENT**

The revised National Curriculum Statement (NCS) was adopted in 2002. It aims to develop the full potential of all learners as citizens of a democratic South Africa. It seeks to create a lifelong learner who is confident and independent, literate, numerate and multi-skilled. The NCS has been phased in gradually throughout the grades and culminates in the phase-in of the new curriculum in Grade 12 in 2008. The National Protocol on Assessment, which regulates the recording and reporting of learner achievement of learning outcomes for Grades R to 12, has been finalised and gazetted (OECD, 2008: 41).

The adoption of the Constitution of the Republic of South Africa (Act 108 of 1996: 2) provided a basis for curriculum transformation and development in South Africa. The Preamble states that the aims of the Constitution are to:

- Heal the divisions of the past and establish a society, based on democratic values, social justice and fundamental human rights.
- Improve the quality of life of all citizens and free the potential of each person.
- Lay the foundations for a democratic and open society in which government is based on the will of the people, and every citizen is equally protected by law.
- Build a united and democratic South Africa that is able to take its rightful place as a Sovereign State in the family of nations.

The Constitution further states that “everyone has the right ...to further education which the State, through reasonable measures, must make progressively available and accessible”. The National Curriculum Statement Grades 10 – 12 (General) lays a foundation for the achievement of these goals by stipulating Learning Outcomes and Assessment Standards, and by spelling out the key principles and values that underpin the curriculum (Department of Education, 2003: 1).

The National Curriculum Statement consists of 29 subjects. Subject specialists developed the Subject Statements, which make up the National Curriculum Statement. The draft versions of the Subject Statements were published for comment in 2001 and then re-worked to take account of the comments received. During 2002, twenty-four subject statements and an overview document were promulgated in the Government Gazette (Department of Education, 2008: 2).

### **3.4.1 Principles of the National Curriculum Statement**

The Department of Education (2003: 1) states that the National Curriculum Statement Grades 10 – 12 (General) is based on the following principles:

- Social transformation.
- Outcomes-based education.
- High knowledge and high skills.

- Integration and applied competence.
- Progression.
- Articulation and portability.
- Human rights, inclusivity, environmental and social justice.
- Valuing indigenous knowledge systems.
- Credibility, quality and efficiency.

### **3.5 TEACHING AND LEARNING**

Teaching and learning in Mathematics focuses on the development of learners towards the four Learning Outcomes through the attainment of the Assessment Standards for each grade. The four Learning Outcomes propose that learners will be able to; recognise, describe, represent and work confidently with numbers and their relationships; estimate, calculate and check solutions, investigate, analyse, describe and represent a wide range of functions and solve related problems; describe, represent, analyse and explain properties of shapes in 2-dimensional and 3-dimensional space with justification, and collect, organise, analyse and interpret data to establish statistical and probability models to solve related problems. Central to the attainment of the Learning Outcomes is the development of mathematical process skills (e.g. investigating, conjecturing, organising, analysing, proving, problem-solving, modelling) Through the use of these skills, knowledge and understanding important concepts in Mathematics are built up progressively from grade to grade. The teaching and learning is furthermore embedded in contexts that nurture appropriate values and attitudes, while relating to real life situations (Department of Education, 2008: 11).

Mathematics is a concept and process-driven subject. However, the teaching and learning of Mathematics cannot be presented in a vacuum. Mathematics should enable learners to establish an authentic connection between Mathematics as a discipline and the application of Mathematics in real-world contexts. Mathematical modelling provides learners with a powerful and versatile means of mathematically analysing and describing their world (Department of Education, 2008: 11). Mathematical modelling involves identifying and selecting relevant features of real-

world situations, representing those features in mathematical representations, quantitatively and qualitatively analysing the model and the characteristics of the situation, and considering the accuracy and limitations of the mathematical model. Mathematical modelling allows learners to deepen their understanding of Mathematics, while expanding their repertoire of mathematical tools for solving real-world problems (Department of Education, 2008: 11).

### **3.6 PHYSICAL SCIENCES AND THE NATIONAL CURRICULUM STATEMENT PRINCIPLES**

The nine National Curriculum statements principles should be implemented at all schools. The Physical Science curriculum supports the application of the nine National Curriculum Statement principles as follows (Department of Education, 2008: 8):

#### **3.6.1 Social transformation**

Physical Sciences contributes to social transformation by ensuring the development of scientifically literate citizens who are responsible and can critically debate scientific issues, and participate in an informed way in democratic decision-making processes. The curriculum in Physical Sciences addresses the historical limitations of poor quality or lack of education in certain sectors by ensuring increased access to scientific knowledge and literacy for learners.

#### **3.6.2 Outcomes-Based Education**

Physical Sciences makes use of Learning Outcomes to describe what the learner should achieve and Assessment Standards describe what a learner should know and be able to demonstrate (i.e. the skills, knowledge, values and attitudes) by the end of each grade. Emphasis is placed on the application and construction of knowledge, and the understanding of the relationships between scientific and technological knowledge, and socio-economic development. The activity-based approach to teaching, learning and assessment in Physical Science encourages learners to develop inquiry and problem-solving skills, which support the practical application of knowledge in new situations.

### **3.6.3 High knowledge and high skills**

The subject Physical Sciences aims to develop high-level knowledge and skills for all learners. The Physical Sciences curriculum fulfils this aim by developing scientific inquiry and problem-solving skills, conceptual knowledge and a broadened understanding of the impact Physical Sciences has on the quality of sustainable socio-economic and human development. This is achieved by critically evaluating the interrelationships between Physical Sciences and technology, society, ethics and the environment. Through the Learning Outcomes (LOs) and Assessment Standards (ASs) of Physical Sciences, teaching and learning aims at intellectual accomplishment with acquisition of a broad range of skills, gains in knowledge and understanding, recognition of changes in values and attitudes as well as the ability to apply these competencies to promote sustainable development. In addition, Physical Sciences places particular emphasis on creating opportunities for all learners to realise their full potential as thinking and doing beings who will contribute to an improved quality of life for themselves and others in society.

### **3.6.4 Integration and applied competence**

Integration is achieved within and across subjects. Integration within Physical Sciences is achieved by the close relationship between the Learning Outcomes, Assessment Standards and the content. It is therefore important to note that no single outcome can be addressed on its own. The planning of learning units must reflect the integration of different Learning Outcomes. However, some of the Learning Outcomes can be dealt with better in one specific context than in another, but all Learning Outcomes must be covered and addressed in an integrated manner. Applied competence aims at integrating practical, foundational and reflective competencies. Integration is also achieved across subjects.

### **3.6.5 Progression**

The Assessment Standards for each Learning Outcome in the National Curriculum Statement Grades 10-12 (General) are designed at various levels of complexity and depth to provide for progression as learners move from the beginning to the end of a grade, and from grade to grade. Within Physical Sciences examples of progression can be seen when looking at the first Assessment Standard of Learning Outcome 1 for Grades 10-12 where the Assessment Standard increases in complexity by



moving from focusing on identifying and questioning phenomena to finding reasons for the occurrence of certain phenomena through surveys, which involve more than one variable. The development and integration of high levels of knowledge, values and skills within and across different grades in the band is important in the study of the Physical Sciences. The increasing levels of complexity and depth required as learners progress through the band are reflected in the Assessment Standards.

### **3.6.6 Articulation and portability**

The Physical Sciences Learning Outcomes are closely related to the Natural Sciences Learning Outcomes of the National Curriculum Statements (NCS) Grades R-9. This ensures continuity and further development of the skills, knowledge, values and attitudes acquired in Grades R-9. In Physical Sciences the Learning Outcomes, Assessment Standards and content framework will allow mobility and portability across and within Grades 10-12, as well as access to the Higher Education and Training Band.

### **3.6.7 Human rights, Inclusivity, Environment and Socio-Economic Justice**

The Physical Sciences should contribute to promoting a culture of human rights, inclusivity and socio-economic justice. In studying the Physical Sciences learners should be aware of, and sensitive to issues such as environmental management, inequality, disability, gender, barriers to learning, indigenous knowledge, and the impact of Science and Technology on socio-economic development of communities.

### **3.6.8 Valuing Indigenous Knowledge systems**

In Physical Sciences, learners are required to research, discuss, compare and evaluate claims made by scientific and Indigenous Knowledge Systems by indicating the relationship between them. Indigenous knowledge systems in the South African context refer to the body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years, for example, the making of African beer as compared to the traditional western methods of manufacturing beer. Nowadays people recognise the wide diversity of knowledge systems through which people make sense, and attach meaning to, and the world in which they live. Physical Sciences recognises the richness of indigenous knowledge systems and their contribution to the learner and society.

### **3.6.9 Credibility, Quality and Efficiency**

The National Curriculum Statement Grades 10-12 (General) aims to achieve credibility through pursuing a transformational agenda and through providing an education that is comparable in quality, breadth and depth to that of other countries. The credibility and quality of the Physical Science curriculum is evident in that its focus areas (matter and materials; chemical systems; chemical change; mechanics; waves, sound and light; electricity and magnetism) are internationally recognised as relevant areas for the learning, teaching and assessment of Physical Sciences.

## **3.7 MATHEMATICS AND THE NATIONAL CURRICULUM STATEMENT PRINCIPLES**

The nine National Curriculum statements principles should be implemented at all schools. The Mathematics curriculum supports the application of the nine National Curriculum Statement principles as follows (Department of Education, 2008: 8):

### **3.7.1 Social Transformation**

Mathematics and Mathematical Literacy are of fundamental importance to the building of a competitive nation and a thriving democracy. All learners in Grades 10-12 should be given the opportunity of developing themselves mathematically. All learners being offered the subject are empowered by the emphasis on the development of process skills as opposed to rote learning of procedures and manipulative skills.

### **3.7.2 Outcomes-Based Education**

The teaching and learning of Mathematics works towards the attainment of the 12 Critical and Developmental Outcomes.

The Critical Outcomes require learners to be able to:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively with others as members of a team, group, organisation and community;
- organise and manage themselves and their activities responsibly and effectively;
- collect, analyse, organise and critically evaluate information;

- communicate effectively using visual, symbolic and/or language skills in various modes;
- use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

The Developmental Outcomes require learners to be able to:

- reflect on and explore a variety of strategies to learn more effectively;
- participate as responsible citizens in the life of local, national and global communities;
- be culturally and aesthetically sensitive across a range of social contexts;
- explore education and career opportunities; and
- develop entrepreneurial opportunities (Department of Education, 2003: 2).

These guidelines will assist the teacher in developing Learning Programmes, which support the achievement of these 12 outcomes.

### **3.7.3 High knowledge and high skills**

The process skills developed in Mathematics are those that enable learners to become mathematicians as opposed to stunting their growth through an emphasis on rote approaches to the subject. Concepts and “big ideas”, key to Mathematics, are progressively developed and ensure the mathematical future of the learner. The Assessment Standards indicate the minimum requirements to be attained, while the system for grading performance allows for the extension to higher levels of knowledge and skills.

### **3.7.4 Integration and applied competence**

An integrated understanding of mathematical concepts is provided for in the holistic view of the Learning Outcomes, as well as in the requirement that learners use existing knowledge and understanding to solve problems as a basis for further development. The emphasis on mathematical modelling in dealing with real life contexts empowers the learner to apply the Mathematics learned.

### **3.7.5 Progression**

In developing the Assessment Standards, care has been taken to provide for conceptual and skill progression from grade to grade. This is evident in the layout of these standards in the Subject Statement.

### **3.7.6 Articulation and portability**

Any learners being offered. Mathematics in Grades 10-12 will be working towards the same Learning Outcomes. A learner who achieves the Assessment Standards for Mathematics will be well prepared for the Mathematics required by Higher Education Institutions.

### **3.7.7 Human rights, inclusivity and environmental and social justice**

To ensure that human rights issues are emphasized, teachers are encouraged to develop lesson plans that include appropriate contexts. Quantitative arguments are often used in arguing for and against developments that could affect the environment negatively. Appropriate Assessment Standards have been included, which challenge learners to critique such arguments. Learning Outcome 4 (Data Handling) is particularly suited to dealing with statistics on a wide range of issues of social justice and in appreciating the threat posed by HIV and AIDS.

### **3.7.8 Valuing Indigenous Knowledge Systems**

Learners in Grades 10-12 come from many cultures that make up the school-going population of South Africa and must be made aware of the Mathematics that is embedded in these cultures. The local environment, for example, local artefacts and architecture, should be studied from a mathematical perspective. Ethnomathematics in South Africa and beyond contributes to the growing body of knowledge in this area.

When learners bring their existing knowledge to bear in problem-solving and communicating about Mathematics, Indigenous Knowledge Systems will be accessed. In particular, the ability of African languages to describe mathematical concepts should be extended.

### **3.7.9 Credibility, quality and efficiency**

The scope provided by the Assessment Standards and the extended opportunities that can be realised by higher grading in attainment ensure that Mathematics is on a

par with the Mathematics taught in corresponding grades internationally. The formative aspects of Continuous Assessment are intended to enhance the efficiency of teaching and learning. External summative assessment will have a strong role in ensuring the credibility of Mathematics in Grades 10-12.

### **3.8 CONCLUSION**

This chapter discussed the policy and legislative framework that governs teaching and learning in South Africa. The South African government has focused on constructing a specific integrated national system. The focus of the government was also to enhance access to education to formally marginalised citizens, as well as the poor.

The curricula for schools required review to show new values and principles, especially those of the Constitution of South Africa. A new national curriculum, which came to be known as Curriculum 2005 (C2005), was launched in 1997 and implemented in phases from the beginning of 1998. C2005 was grounded in outcomes-based education (OBE) principles. While there was much to commend the curriculum, the concerns of teachers led to a review of the Curriculum in 1999. According to the OECD (2008: 80), almost immediately after its introduction, Curriculum 2005 raised controversy.

The focus of the new national curriculum is on gaining knowledge and skills to actively participate in a democratic community and to support the South African economy. It is therefore imperative that all schools implement the nine National Curriculum statement principles. The next chapter focuses on research methodology used in gathering empirical data for this study.

## **CHAPTER FOUR**

### **RESEARCH METHODOLOGY**

#### **4.1 INTRODUCTION**

Henning (2004: 36) refers to methodology as the coherent group of methods that complement one another, and that have the “goodness of fit” to deliver data and findings that will reflect the research question and suit the research purpose. Cohen, Manion and Morrison (2007: 47) state that research methods are a “range of approaches used in research to gather data, which is to be used as a basis for inference and interpretation, for explanation and prediction”. The main objective of this chapter is to highlight the research paradigm, research design, data collection strategies, and data analysis. Because of confidentiality, the names of the two schools that were under investigation will not be revealed in the study, but will be referred to as School A and School B throughout the study.

#### **4.2 RESEARCH PARADIGM**

Groenewald (2004:7) refers to a paradigm as “a model or the patterning of the thinking of a person, and it is the theory of knowledge that allows the researcher to decide how the research phenomenon will be studied”. De Vos (2001:242) contends that there are two paradigms that determine the direction of a research project from its commencement to the last step of writing the research report. These paradigms are qualitative and quantitative research approaches.

##### **4.2.1 Qualitative Research**

According to Struwig and Stead (2001:12), qualitative researchers are interested in understanding the issues being researched from the perspective of the research participants. In other words, they are trying to see through the eyes of the participants. Qualitative research, according to Miles and Huberman (1994: 10), is a type of primary research in which the researcher collects first-hand information obtained directly from participants. In this study, data will be collected from Grade 12 learners, Grade 12 educators, and principals in the targeted schools. The research will investigate contributory factors to low success rates in science and mathematics subjects at Grade 12 level at the schools under study. In order to achieve the aim of the study, qualitative research methods will be followed.

#### **4.2.1.1 Interpretive paradigm**

Creswell (2007:37) defines qualitative research as an interpretive and naturalistic approach that explains social and human problems. Qualitative research may mean many things to different people (Denzin & Lincoln, 2005:4), but is ultimately characterised by the commitment to seek an understanding of the world through interacting with the participants and interpreting their actions and perceptions by concentrating on the qualities of human behaviour (Creswell, 2005:175).

According to McFarlane (2000:27), the interpretive paradigm includes many research traditions which originate from various fields of study. These fields of study, however, share the same objective, namely to understand and to interpret social situations by becoming part of the situation, or becoming close to the people involved in the social situation, to listen to and to share people's experiences and perceptions. Neuman (2003:61) shares the view of McFarlane by stating that "the interpretive theorist attempts to discover the meaning of an event or practice by placing it within a specific social context".

Terre Blanche and Durrheim (1999:127) assert that interpretive researchers do not work with data, which they describe as bits of discrete information that can be extracted from their context. They typically work with material that is richly interrelated and would lose its meaning if broken into discrete bits. They want to make sense of feelings, experiences, social situations or phenomena as they occur in the real world, and therefore want to study them in their natural setting.

According to Stringer (2004:26, 35), and Gay and Airasian (2000:18), qualitative research provides the means to understand the ways in which people experience, feel and interpret an event. Grix (2004:32) further states that qualitative research interprets the subjective experiences, for example, the perspectives of the individuals being studied. In this study, the researcher will interview school principals and hand out questionnaires, which are mostly open-ended, to the teachers and learners, in an attempt to understand their experience and their perspectives on the pass rate of Grade 12 learners in science and mathematics subjects.

### **4.3 RESEARCH DESIGN**

According to McMillan and Schumacher (1996:33), the research design refers to the plan used by the researcher to obtain evidence in order to obtain answers to research questions. Takona (2002:16) adds that research methodology refers to the principles and procedures underlying systematic inquiry. A research design is a strategic framework for action that serves as a bridge between research questions and the execution or implementation of the research. Research designs are plans that guide the arrangements of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It is the designed and planned nature of observation (Terre Blanche & Durrheim, 1999: 29). Babbie and Mouton (2001: 72) state that there are two major aspects of research design. Firstly, they say, one needs to specify as clearly as possible what one wants to find out. Secondly, one must decide the best way to do it.

Burns (2000:3) states that one of the strengths of qualitative descriptions is that it can play an important role in suggesting possible relationship(s), causes, effects and even dynamic processes in school settings. Babbie and Mouton (2001: 270) state that qualitative researchers attempt always to study human action from the perspective of the social actors themselves. They contend that the primary goal of studies using a qualitative approach is defined as describing and understanding rather than explaining human behaviour. The objective of this study is to provide an understanding of causative factors of the low pass rate in science and mathematics of Grade 12 learners, identify key significant variables that contribute to these factors, and for this reason, a qualitative approach to the study will be pursued. According to Berg (2004: 7), techniques allow the researcher to share in the understanding and the perceptions of the participants and to explore how people structure and give meaning to their daily lives. The researcher will make use of questionnaires and interviews to collect qualitative data.

Terre Blanche and Durrheim (1999: 44) define sampling as that which involves decisions about which people, settings, events, behaviours and social processes to observe. They also classify sampling as a process which is used to select cases for inclusion in a research study. Babbie and Mouton (2001: 164) give an almost exact definition by writing that sampling is the process of selecting observations. They identify purposive sampling as one method of sampling (Babbie and Mouton, 2001:



166). According to Merriam (1998: 12), purposive sampling is based on criteria determined by the researcher as to who is interviewed or what sites are observed. The research will be conducted at two schools in the Northern areas of Port Elizabeth. The two schools were purposely chosen because they both offer science and mathematics to Grade 12 learners.

A literature study has been done in order to determine what other authors and researchers have found regarding science and mathematics education, which entailed an in-depth exploration of theories associated with science and mathematics education. The planning of the research included choosing research methods that suitably linked up with the aims of the research. The research paradigm will guide the researcher in using appropriate data gathering techniques. The data gathered by the researcher will be compared with the literature from the literature study.

#### **4.3.1 Population**

According to Best and Kahn (1993:13), a population is, "Any group of individuals that have one or more characteristics in common that are of interest to the researcher". The target population of this study will be school principals, school teachers, and school learners, selected from secondary schools in the Northern Areas of Port Elizabeth. Two schools were chosen by the researcher. These schools were chosen because they both offer science and mathematics to Grade 12 learners, and each of the schools experienced low pass rates in science and mathematics in recent years at Grade 12 level. These pass rates were a cause for concern to the researcher. Both schools share similar characteristics in terms of their socio-economic conditions, population groups and class sizes. The schools were also selected on their willingness to participate in the research.

#### **4.3.2 Purposive sampling**

Struwig and Stead (2001:121) state that qualitative researchers select samples purposefully rather than randomly. They say purposeful sampling provides a sample of information-rich participants. The following considerations were used in the selection of the schools:

- Geographical location

The participants involved in the study will be chosen from schools within the Northern areas of the Nelson Mandela Metropole that will be easily accessible to the researcher.

- Types of schools

The researcher will select research participants from government high schools which offer science and mathematics to Grade 12 learners, which have experienced low pass rates in these subjects at Grade 12 level in recent years.

- Research participants

The participants will include high school principals, Grade 12 science educators, Grade 12 mathematics educators, and Grade 12 science and mathematics learners. The participants will be purposely chosen because each one of them has experience of, and views on science and mathematics education at Grade 12 level.

#### **4.3.3 Research Sample**

A sample of respondents will be chosen from the target population, which will include 2 school principals (one from each school), 2 mathematics teachers (one from each school), 2 physical science teachers (one from each school), and 46 science and mathematics learners (23 learners from each school). The sample will be purposely chosen because all the respondents are directly linked to the teaching and learning of science and mathematics at Grade 12 level. Learners will be chosen for the study on the basis that they are enrolled at one or other of the schools and are Grade 12 science and mathematics learners. Teachers and principals will be chosen on the basis that they teach at one or the other of the two selected schools.

#### **4.4 DATA COLLECTION INSTRUMENTS AND METHODS**

The course of action for the data collection process that the researcher will follow, will include obtaining permission in gaining access to the two schools, presentation of oneself and becoming acquainted with the research subjects, explaining the data collection procedure, and utilising the data collection instruments.

Qualitative research methods involve the capturing of people's opinions, feelings and practice, their experience and the kind of atmosphere and context in which they act and respond (Wisker, 2001:164). This, by implication, means that the researcher has to use physical techniques for obtaining the data from the different participants and

sources. The data collection methods intended to be employed will be questionnaires (mostly open-ended) and semi-structured interviews.

#### **4.4.1 The Questionnaires**

The researcher was guided by the following definitions, and hence questionnaires have been developed in order to gather facts and opinions from the respondents about their views on factors that influence low success rate in science and mathematics learners at Grade 12 level. According to Thomas (2003:66), a questionnaire is a printed set of questions used to gather facts and respondents' opinions. Davies (2007:82) points out that questionnaires are aimed at facilitating communication either in writing, in the form of a conversation, or electronically.

Questionnaires have been designed to obtain the facts and opinions needed to answer the research question, and will be administered to Grade 12 science and mathematics learners and educators. An opportunity will be given to respondents to ask for clarification on questions they have difficulty in understanding. After completion, questionnaires will be collected by the researcher.

##### **4.4.1.1 Open ended questions**

Open-ended questions have been included to allow participants to answer in their own words and to express any ideas they think might be relevant (Struwig & Stead, 2001:92). The most important part of the actual design of questionnaires is to construct them unambiguously and clearly so that respondents will have no problem in interpreting what is being asked (Williams, 1997:92). Clarke (1999:68) states that a questionnaire can be used to collect information from individuals participating in randomised control trials. It provides a wealth of descriptive data pertaining to individuals or groups. Open-ended questions can sometimes be difficult to interpret or analyse, but can also be used to put the respondents at ease because they can express themselves in their own words (Hofstee, 2006:133). Respondents also have the opportunity to elaborate on their answers where the need arises. Arguing along similar lines, Clarke (1999:70) points out that open-ended questions allow respondents to answer in their own words, rather than being restricted to choosing from a list of pre-coded categories.

The learner questionnaire has been constructed in line with the aims of the research, which is to explore the perceptions and experiences of learners regarding science

and mathematics at Grade 12 level. The learner questionnaire includes open-ended questions on the following areas; desired career paths of learners, factors that motivate and demotivate learning, content knowledge, and challenges faced by learners with regard to science and mathematics at Grade 12 level. The main objective of the learner questionnaire is to expose challenges faced by Grade 12 learners regarding science and mathematics at Grade 12 level, Which could as as hindrances in the pass rate.

Grade 12 science and mathematics teachers are considered important role players in this regard. For this reason, Grade 12 science and mathematics educators at the two schools were chosen as part of the research sample and the researcher constructed a questionnaire for them, which covered the following areas; teacher motivation and confidence, the Grade 12 syllabus, outcomes-based education, classroom practice, and learner support. The main objective of the educator questionnaire is to unveil the experiences of and views on science and mathematics education at Grade 12 level that educators have.

#### **4.4.1.2 Closed-ended questions**

Terre Blanche, Durrheim and Painter (2006:487) believe that closed-ended questions do not allow respondents to provide answers in their own words, but force respondents to select one or more choices from a fixed list of answers provided. They go on to state that closed-ended questions have the advantage of eliciting a standardised set of responses from all the respondents, and thus allow for easier comparative data analysis.

The learner questionnaire includes closed-ended questions on the following areas; school resources, classroom practice (including language usage), homework, and time spent on revision. The educator questionnaire includes closed-ended questions on the following areas; school resources, teacher qualifications, and teaching experience.

#### **4.4.2 Interviewing as Research Method**

Terre Blanche and Durrheim (1999:127) maintain that interviewing falls within the interpretive tradition or paradigm. They are of the opinion that interviewing gives the

researcher the opportunity to get to know the respondents quite intimately, so as to really understand how they think and feel. They report that the purpose of interviewing is to find out what is in and on someone else's mind. With qualitative research interviews, they say, one tries to understand something from the subjects' point of view and to uncover the meaning of their experiences.

Interviewing is one of the most common methods of data collection used by researchers to inform them about social life. Interviewing could thus be regarded as the universal mode of systemic enquiry (Holstein & Gubrium, 1995:1). Interviewing is especially useful in a qualitative study as one can gain rich and descriptive data through this type of data collection. In particular, the semi-structured interview requires the respondent to answer predetermined questions, but also allows for clarification of responses and probing (Nieuwenhuis, 2007: 87).

#### **4.4.2.1 Face-to-face interviewing**

Face-to-face interviews of the principals will take place at each of the two selected schools, in order for the researcher to elicit as much information as possible from the respondents. The technique of individual face-to-face interviewing treats the interview as a pipeline for extracting and transmitting information from the interviewee to the interviewer, and through open-ended interviews, the researcher is able to record direct words of the interviews (De Vos, 2001:297). This researcher will make use of in-depth, open-ended interviews with the principals in order to assist the researcher to understand the factors that are associated with the low level of success rates in science and mathematics at Grade 12 level.

The principal interview schedule was guided by one of the aims of this study, which is concerned with attaining higher levels of pass rates of Grade 12 learners in science and mathematics. It is the opinion of the researcher that school principals hold vital information about teaching and learning and for that reason, principals will be interviewed. Open-ended interview questions cover the following areas; motivation and interest of teachers and learners, factors believed to contribute to time lost during teaching and learning, outcomes-based education, assistance from District Offices, high failure rates of science and mathematics at grade 12 level, and Grade 12 examinations. Closed-ended interview questions cover the following areas;

experience and qualifications of principals, school resources, teacher/pupil ratios, and in-service training.

#### **4.4.3 Data analysis**

Subsequent to data-collection, will be the recording and decoding of information retrieved from the questionnaires and interviews. Analysis involves breaking up the data into manageable themes, patterns, trends and relationships (Mouton, 2001:108). This allows the researcher to organise the data into smaller sections, so that any obvious repetitions or errors may be easily noticed. The action of data analysis can be described as a process of bringing order, structure and interpretation to a massive amount of data in search of general statements about relationships and underlying themes that build grounded theory (Marshall and Rossman, 2006:154).

Burns (2000:431) asserts that data analysis can be done by systematically arranging and presenting the data. De Vos (2002:344) states that the classification of the data collected entails unpacking the data with the intention of finding categories or themes of information. Marshall and Rossman (2006:156) regard this categorising process as the most fundamental operation in the analysis of qualitative data, because it requires the researcher to discover significant classes of things, persons and events, and the properties that differentiate them. These manageable themes are then written into different narratives. Gay and Airasian (2000:25) state that in qualitative research, the researcher collects data from a small number of selected participants and makes use of a non-numerical, interpretive approach to provide narrative descriptions of the interviewees and how they see their contexts. A statistician will be used to quantify the data.

#### **4.5 ETHICAL CONSIDERATIONS**

According to Struwig and Stead (2001:66), conducting research is an ethical enterprise. The researcher will have to take into account ethical considerations and procedures that need to be applied when conducting research. Such ethical considerations are required by Nelson Mandela Metropolitan University (NMMU). The permission to conduct the research has been obtained in advance from the NMMU Research Ethics Committee (Human). May (1997:54) defines the concept 'ethics' as a set of standards by which a particular group or community decides to regulate its behaviour and to distinguish what is legitimate or acceptable in pursuit of

its aims. Basic ethical principles are based on what is right or just, in the interests of not only the project, but also those participating in the research. To conduct research in an ethical manner means carrying out research competently, managing resources honestly, acknowledging those who contributed guidance or assistance, communicating the results accurately, and considering the consequences of the research for society (Brink, 2001:37).

Wiersma (2000:418) emphasises the need to obtain permission from an approving body if the research is conducted in an educational setting. In compliance with this requirement, the researcher has obtained the permission from the Eastern Cape Department of Education before conducting the research. Permission from the school principals will also need to be sought before starting with the data collection. The researcher will have to ensure that she acts in accordance with the rules and regulations concerning research in public schools as set out by the Department of Education. The researcher will approach principals and teachers of the two selected schools to obtain permission to conduct the study. The school principals and educators will have to give their consent to take part in the study. Because learners included in the sample are minors, the permission of their parents will have to be sought by the researcher prior to the participation of learners in the study.

All participants will be fully informed about the purpose of the study according to the guidelines offered by Neuman (2003:124) who advises that informed consent to participate in the study must be sought from the participants and must include the following:

- A brief description of the purpose and procedure of the research.
- A statement of any risks or discomfort associated with participation.
- A guarantee of anonymity and the confidentiality of records.
- A statement that participation is completely voluntary and can be terminated at any time without penalty.
- A statement of any benefits or compensation provided to subjects and the number of subjects involved.
- An offer to provide a summary of findings.

All participants will be assured of anonymity and privacy during the study. A guarantee will be given to all participants that they will be at liberty to decline to continue with the study at any stage if they so wish. Participants will be informed that no remuneration will be awarded for involvement in the study. Interviewees' permission for tape recording will be sought prior to interviewing. All names and addresses of participants will be deliberately omitted from the study.

#### **4.6 VALIDITY**

Silverman (1995:149) states that validity is the extent to which an account accurately represents the social phenomena to which it refers. Neuman (2003:185) simply defines validity as truthful. He, however, adds that; "qualitative researchers are more interested in authenticity than validity. Authenticity means giving a fair, honest, and balanced account of social life from the viewpoint of someone who lives it every day". Truthfulness, fairness and honesty in this study will be established through validation of data by the participants themselves.

The researcher will try to ensure validity by taking into account the advice of Silverman (1995:149), who suggests that a means of establishing validity is taking one's findings back to the subjects being studied to be verified. This is called respondent validation. In this study, findings will be taken back to the respondents for them to verify that what was captured was actually what they said. Terre Blanche and Durrheim (1999:313) concur and add that external validity is when its findings can be generalised beyond the confines of the design and the study setting. This implies that the results of this study can be applied to all high schools in the Northern areas of Port Elizabeth.

#### **4.7 CONCLUSION**

This chapter highlighted the research paradigm, research design, data collection strategies, and data analysis. The research design drew attention to the process that the researcher will follow in order to answer the research question.

A qualitative research approach will be followed by the researcher so as to see through the eyes of the participants.

In this study, the researcher will interview school principals and hand out questionnaires, which are mostly open-ended, to the teachers and learners, in an



attempt to understand what they experience and how they feel about the low success rate of Grade 12 learners in science and mathematics education.

The course of action for the data collection process that the researcher will follow, will include, obtaining permission to gaining access to the two schools, presentation of oneself and becoming acquainted with the research subjects, explaining the data collection procedure, and utilising the data collection instruments. The data collection methods intended to be employed will be questionnaires (mostly open-ended) and semi-structured interviews. The next chapter focuses on interpretation and analysis of empirical findings.

## **CHAPTER FIVE**

### **INTERPRETATION AND ANALYSIS OF EMPIRICAL FINDINGS**

#### **5.1 INTRODUCTION**

This chapter will report on the findings of the survey by means of an in-depth analysis of empirical findings and will focus on the specific themes that emerged during the study. The data obtained from the individual interviews and questionnaires have been analysed and are presented and interpreted. Deliberate attempts are made to connect the findings to existing literature on the topic.

As previously mentioned, the research for this study was conducted at two State high schools in the Northern Areas of Port Elizabeth in the Eastern Cape during 2012. The term 'Northern Areas' refers to the residential suburbs in the Northern Areas of Port Elizabeth. Twenty two of the learners from both schools come from impoverished communities, which are characterised by overcrowding and a high unemployment rate. Learners from these communities generally underperform academically.

MacDonald and Rogan (1988: 234) argue that some school environments demotivate learning. School environments that can be demotivating include poor physical structures such as dilapidated buildings, and lack of facilities such as science equipment, laboratories, and libraries, particularly in rural schools.

#### **5.2 PARTICIPANTS OF THE STUDY**

A sample of respondents was chosen from the target population of 52 participants. They included 2 school principals (one from each school), 2 mathematics teachers (one from each school), 2 physical science teachers (one from each school), and 46 science and mathematics learners (23 learners from each school). Of the forty six learners, thirty eight learners received both physical science and mathematics instruction, and eight learners received mathematics instruction and not physical science. The sample will was purposely chosen because all the respondents are directly linked to the teaching and learning of science and mathematics at Grade 12 level. Learners were chosen for the study on the basis that they are enrolled at one or other of the schools and are Grade 12 science and mathematics learners.

Teachers and principals were chosen on the basis that they teach at one or the other of the two selected schools.

### **5.3 ACCESS TO RESOURCES**

All of the forty six learners that were participants in the study indicated that they have physical science and mathematics textbooks. All of the four teachers and forty six learners from both schools reported that their school has a library. However, the library at one of the schools was non-functioning. The four of the teachers reported that each respective school does have science equipment and a science laboratory, although one of the physical science teachers reported that the science laboratory at her schools was not operational.

A total of eight learners from both schools indicated that they receive Computer Applications Technology (CAT) instruction as a school subject. These learners reported that they have access to a computer at school. Those who did not receive CAT instruction, indicated that they did not have access to a computer at school. Of the learners who received CAT instruction, indicated that all eight of them are capable computer users who are able to work in different computer programmes.

Thirty of the forty six learners under investigation pointed out that the biggest factor that contributes to demotivating them from learning is not understanding the school work. They maintained that when one portion of the work was not understood, the whole subject became uninteresting. Ten out of twenty three mathematics learners pointed out that mathematics at Grade 12 level was too difficult to understand, and this frustrated them. Eleven of forty six learners mentioned that their home environments were not conducive to studying. Poor physical structures such as dilapidated buildings were not attributed as obstacles to learning.

Qhobela and Rollnick (2010: 6) report that most schools are characterised by, inter alia, overcrowded classrooms and laboratories, which is coupled with a severe shortage of science teachers. Both of the physical science and mathematics teachers from both schools indicated that they did not experience overcrowding in their classrooms at Grade 12 level. this was confirmed by both principals. All four of the teachers did, however, indicated they experienced overcrowding in lower grades.

#### **5.4 THE CHOICE OF SCIENCE AND MATHEMATICS IN SCHOOLS**

According to Robottom and Hart (1993: 591), a greater number of science graduates results in a more skilled, and therefore a more productive workforce, which in turn contributes to an internationally more competitive nation which redresses the balance of trade problems. The low success rate of Grade 12 learners in science and mathematics has a negative impact on the overall pass rate of Grade 12 learners. It has a negative influence on the future prospects of learners who cannot successfully pursue careers of their choice.

When questioned about the rationale for choosing physical science and mathematics as school subjects, the general trend in the answers that learners gave was that physical science and mathematics at matric level is a requirement in order for them to follow the career path of their dreams. Twenty of the forty six mathematics learners indicated that they chose to do mathematics as a subject because they did not want to be limited with regard to career choices after completing their school careers. These learners believe that having mathematics at Grade 12 level will enable them to follow any career path as it could open doors for them after matric. They were of the opinion that there were many options available to mathematics learners with regard to career choices. Some of the learners pointed out that having mathematics as a school subject could assist in securing jobs for them after matric.

When questioned about career paths that they wished to follow after matric, twenty eight of the thirty eight learners who desired to follow careers which involve physical science and mathematics, reported that they would not be able to pursue such careers because of the fact that they performed poorly in these two subjects. Those learners who desire to follow careers which involve physical science and mathematics tend to experience difficulties to get admitted in fields such as medicine, science, and technology at tertiary institutions, although they pass all their other subjects. These learners referred to their mathematics examination results as a hindrance. Even those learners who wished to pursue careers in business, indicated that they were not able to do so as a consequence of failing mathematics. Only four out of forty six learners indicated they were able to pursue career paths of their choice with the examination results that they obtained.

## **5.5 LEARNER MORALE**

The four teachers from the two schools reported that the majority of learners' motivational levels were very low and they had low self-esteem. These teachers at both schools pointed out that Afrikaans-speaking learners' level of motivation was low because their support structure at home was inadequate, whereas English-speaking learners appeared to be more motivated because their parents were able to assist the learners with their schoolwork, or if not, their parents could afford to pay for extra tuition for them. Moreover, these teachers stated that learners constantly needed to be reminded of their potential. They also reported that learners are eager to learn most of the time, but because of uncertainty due to lack of sufficient exposure to the necessary resources to physical science they become despondent when not being able to arrive at the correct answer. The teachers at both schools made comparisons between English-speaking and Afrikaans-speaking learners because the majority of the Afrikaans-speaking learners live in areas of low socio-economic conditions, whereas the English-speaking learners live in areas in which the socio-economic conditions are somewhat better.

According to all of the teachers, very few learners were goal-directed. They believed that learners have a vague idea of the career they would like to follow, but did not realise the hard work they needed to put in to realise their dreams. One of the teachers stated that learners did not view education as a means to break their social poverty cycle. All of the four teachers reported that learners were easily discouraged. Omoregbe (2010: 176) points out that parental educational level is known as a factor positively related to children's academic achievement. He goes further to state that family is the main factor influencing the lives and outcomes of learners and the educational level of parents is a powerful factor influencing children's academic success.

Based on the comments made by teachers made about the reasons for learners' particular level of motivation, it is evident that these teachers were concerned about the lack of parental interest and involvement in learners' school careers. The teachers believed that uninvolved parents, the socio-economic background of learners, lack of interest, concern, and motivation of parents from a young age, lack of good role models, drug and alcohol abuse by learners, type of community the learners come from, and lack of parental guidance are all factors that contributed to

low motivational levels. Eleven of the learners admitted that not being encouraged by their families contributed to their demotivation to learn them, whilst thirty of them pointed out the main factor that contributed to their demotivation was school work that they did not understand.

## **5.6 LEARNER PERFORMANCE**

Poor socio-economic background of learners, poor incentive to study at home, lack of appropriate learner-support materials, general poverty of school environment, general poor quality of teachers and teaching (including poor subject knowledge and poor motivation), language of instruction (often not the same as learners' mother tongue), and an inadequate study orientation, are believed to be causative factors of low success rates of learners, as indicated by Maree, Aldous, Hattingh, Swanepoel and van der Linde (2006: 230). A total of eleven learners out of thirty eight from both schools indicated that they attained an average physical science mark of less than forty percent, and ten with even less than thirty percent. They pointed out that their average mathematics mark ranged from six percent to fifty percent. For the most part, learners indicated that they achieved mathematics examination results that were less than thirty percent. Ninety percent of the learners fail mathematics.

Physical science teacher A reported that English-speaking learners performed well, while Afrikaans-speaking learners did not perform so good. According to the teacher, parents of English-speaking learners were more involved in their children's progress as they checked homework and stayed in contact with their teachers. The teacher also believed that one of the reasons why English-speaking learners performed better was the fact that these learners' parents could afford tutors to assist learners with their homework. One of the teachers reported that learners failed because they did not do their homework. The argument by the teacher was that learners were just happy to pass (attain 30 percent) and they did not attempt to improve their mark. According to the teachers, the average mark that the learners attained in both physical science and mathematics was thirty percent, and most of learners exhibited a weak level of general performance.

All four teachers believed that personal problems, uncommitted learners and uninvolved parents are contributing factors of learners' poor performance at school.

The teachers also believed that gaps in learning and low confidence levels of learners, played a part in the poor performance level.

Mathematics teacher A was of the opinion that learners did not have a mathematical background, but were forced to do the subject because of their subject stream. The teacher stated that she struggled with work in Grade 12 because she was unable to consolidate work at this level with work that was supposed to have been covered in Grade 8 and 9. She indicated that learners in Grade 12 could not, for example, work with fractions and could not multiply without a calculator.

### **5.7 TEACHER EXPERIENCE AND QUALIFICATIONS**

According to Legari (2004: 11), most mathematics and science educators are not qualified to teach these subjects. He reports that in South Africa, out of 84% of science educators who were found to be professionally qualified, only 42% were qualified in science. At these two schools though, this was not the case. When questions were posed to establish teachers' qualifications, it emerged that all four of the teachers were qualified and experienced to teach these subjects. They had academic and professional qualifications, ranging from Bachelors' degrees to Masters' degrees and had been teaching for more than 15 years. It was also found that they received professional formal training in the subjects that they taught.

### **5.8 TEACHER MOTIVATION**

All four of the teachers reported that they were strongly motivated to teach. They did, however, mention some factors that demotivated them including, inter alia, learners who were not motivated to learn, little or no support from a dysfunctional Department of Education, lack of resources, lack of recognition for hard work, ill-disciplined learners who had no desire to learn and expand their knowledge, but expected the teacher to do all the work, administrative demands, unrealistic expectations of parents, and school management that was not committed to the goals and vision of the school.

The continuous change in the school curriculum was also mentioned as hampering some of the teachers' motivation to teach. According to the principals, teachers were constantly involved in extra service training. Both principals pointed out that teachers were usually motivated and interested, but one principal added that teachers had

interest, but did think that any teacher in the province of Eastern Cape was motivated.

## **5.9 OUTCOMES BASED EDUCATION**

The new curriculum is based on a National Curriculum Statement (NCS), which “aims to develop a high level of knowledge and skills in learners” (Department of Education, 2003: 3). According to Glatthorn, Boshee and Whitehead (2004:256), a high level of curriculum implementation can be expected if the curriculum changes are not unduly complex and are clearly explained to teachers; if quality materials supporting the new curriculum are made available to teachers; and if administrators take the necessary steps to prevent and respond to the problem of “overload’ when teachers feel overwhelmed in implementing the curriculum.

When asked to comment whether learners were able to reach their maximum learning potential through OBE in science and mathematics, none of the four teachers believed that learners were reaching their maximum learning potential through OBE. The two mathematics teachers indicated that in mathematics, learners did not reach their potential. They said that the learners they taught were not able to work on their own. Mathematics teacher A said that mathematics was a subject that still needed to be taught because certain topics were abstract, and these were topics that the learners cannot understand on their own. The teacher also said that learners were not eager to complete activities where they had to discover things for themselves. Physical science teacher A argued that if OBE was presented in reality in the same way that it was in the documents of OBE, learners would be able to achieve maximum learning potential. However, the teacher indicated that in real life, this is not happening because learners did not participate and educators were not trained well enough to present the different ways of teaching.

Mathematics teacher B did not believe that learners were reaching their maximum learning potential and said that one of the premise of OBE was that learners did not needed a fountain of knowledge, but to be able to be able to access information. He believed that this was false. He pointed out that as learners reach the senior grades, their lack of knowledge of concepts and skills, which should be second nature at this stage, leads to a gap in their understanding and makes learning difficult. His argument was that most learners were unable to recall even basic ideas and did not



know how to retain knowledge. He further indicated that learners forget something almost immediately after they have heard it. The teacher was on the view that repetition and drilling was not done and concepts were not consolidated and reinforced. His view was that OBE also requires a certain level of reasoning and deduction. However, learners' lack of discerning did not allow them to make deductions and draw conclusions.

Physical science teacher A said that for her, the practice of becoming more of a facilitator than an instructor presented problems because, in her opinion, learners were used to being "spoon-fed", with the result that it becomes a serious matter when they reach Grade 10 (FET band). She also said that a lot of teaching deals with abstract concepts not necessarily easily demonstrated in class and, as a result learners already start their Grade 10 and 11 with a backlog, which creates major gaps in their understanding of chemistry and physical science.

Physical science teacher A who had nineteen years of teaching experience, said that she did not fully understand OBE. She reported that teachers did not receive adequate training in OBE and therefore she did not understand how learners were supposed to reach their full learning potential through OBE. She also pointed out that with lack of resources and a laboratory that was not operational, it is difficult for learners to reach their maximum learning potential. Physical science teacher A stated that learners were not yet able to reach their maximum learning potential through OBE. Her argument was that at primary school level, numeracy and literacy skills of learners were not developed as thoroughly as with the previous syllabus, hence, more and more learners entered high school with enormous backlog with regard to mathematics, science and languages. She therefore argued that learners could not reach their maximum learning potential because they were unable to read, write and do simple science and mathematics problems.

Arguing along similar lines, principal A indicated that learners were not able to reach their maximum learning potential through OBE because teachers were not properly trained for OBE, schools were left practically on their own to interpret OBE, and the Department of Education was not adequately involved in the interpretation of OBE. Principal B argued that learners had not yet reached their maximum learning potential through OBE because of lack of resources.

## **5.10 TEACHING AND LEARNING**

Price and Nelson (2007: 53) maintain that “using various strategies keep students engaged, making them more likely to learn, retain and process the information presented.” In a learner-centred approach, various methods could be used to stimulate learners’ interest in the learning activities, for example, grouping learners for discussion, question and answer method, role plays, drama, brainstorming and debates.

All of the learners indicated that both their physical science and mathematics classroom atmosphere was warm and friendly and reported that their teachers usually showed enthusiasm when teaching. They stated that they were free to participate in the lesson and express their opinions in the classroom. They also stated that they were also free to interact with the teachers and other learners during lessons, but all in a disciplined manner. Learners indicated that they had good interpersonal relationships with their teachers and used the word ‘professional’ to describe their relationships with their teachers. All of the learners indicated that they had the assurance that they might approach their physical science and mathematics teachers to help them if the need arised.

### **5.10.1 The Grade 12 syllabus**

Over the last few decades, a plethora of national plans have originated in developing countries to promote educational provision for economic development. South Africa too, as a result of the new political dispensation of 1994, has followed a similar trend and the problem-centred approach in mathematics has received attention as an alternative to the more traditional approach. The latter is associated with rote learning, learning without the necessary insight, a lack of creativity, a tendency to be too teacher-orientated, and a lack of learner activity (Maree et. al., 2006: 230).

The two mathematics teachers were of the strong view that some of the mathematics topics required prior knowledge, which was no longer in the curriculum. Both physical science teachers pointed out that the provision of resources by the Department of Education to public schools as required by the syllabus was inadequate, yet the Department expected excellent results.

### **5.10.2 Class time allocated to Grade 12 syllabus**

According to Kelly (2004: 126), “each new curriculum requires extra time for teachers to prepare lessons and materials, to become familiar with the new concepts and skills to be taught, to prepare or administer new tests, and to gather reference resources”. Mathematics teacher B said that the class time allocated to the completion of the Grade 12 mathematics syllabus was adequate. He pointed out that sufficient time was allocated, but because of many interruptions, much time for revision was lost.

It appears from the comments made by mathematics teacher B that the time allocated to the Grade 12 year for completion of the mathematics syllabus is not a problem, but this is not the case in the lower grades. However, mathematics teacher B felt that more time is always needed for mathematics. He mentioned that when they have to complete the Grade 11 mathematics syllabus in the matric year, the timeframe becomes a problem.

The two physical science teachers gave dissimilar comments about the time allocated to the Grade 12 physical science syllabus. They felt that it is too short to cover all topics intensively. Both teachers said that time allocated to the completion of the syllabus does not do justice to the depth of information required of the learners during final examination. Physical science teacher B felt that the time allocated to the physical science syllabus is unrealistic. He also said the work was too difficult for learners to fully understand in the short time allocated, and that the syllabus was wide and compact. He was of the opinion that it was useless to rush through the syllabus.

### **5.10.3 Approaches to teaching**

Jacobs, Gawe and Vakalisa (2002:211) state that “teaching method refers to the manner in which the teacher imparts knowledge to learners.” Price and Nelson (2007: 53) maintain that “using various strategies keep students engaged, making them more likely to learn, retain and process the information presented.”

#### **5.10.3.1 Mathematics**

The two mathematics teachers described their respective teaching styles in somewhat different manners. In response to the question on the style of teaching,

Teacher A indicated that his teaching style was relaxed and the approach to teaching was both inductive and deductive (depending on the subject matter to be taught). He did not believe that teachers should be classified in only one way. He was of the opinion that teachers are not the same every day, or even every period. He pointed out that teachers are flexible, and for that reason he classified his teaching style as in between authoritative and indulgent, leaning more towards authoritative.

Teacher A indicated that he engages learners during lessons by posing questions to learners, as well as making random comments in order to elicit a response. He pointed out that he attempts to promote critical thinking through the type of problems and questions he posed to learners. He also pointed out that he demonstrates critical thinking to his learners by using examples that are not worked out prior to classroom (lesson) time. Furthermore, teacher A pointed out that he discusses with learners what information they need to look out for and how to interpret information when working through various questions.

One of Teacher A's learners indicated that teacher A could use simpler methods in his approach to teaching because his concepts were sometimes hard to grasp. The learner pointed out that sometimes the teacher would say things that she would not understand because the words are very difficult. Another learner said that teacher A's teaching methods were confusing because of the pace that he used. She was of the opinion that sometimes the teacher would forget that learners were not on the same mathematical level as he was and, therefore, did not break the work down in order for them to understand better. Another learner felt that she could relate to her mathematics teacher because the teacher was on such an advanced level. Another mathematics learner reported that he could relate to the examples used by teacher A when the teacher used a laptop to assist with the lessons.

Judging by the following comments that the learners used to explain how they relate to Teacher A's teaching style, it appeared that these learners struggle to grasp the understanding of the subject.

In response to the question on the style of teaching, Teacher B indicated that she maintained a very relaxed classroom management style so that learners could feel free to ask questions if need be. This teacher indicated that learners responded

much better in a relaxed atmosphere. She stated that she would want her learners to feel free to communicate with her, as well as with other learners in the classroom. Teacher B felt that in this type of atmosphere, learners are encouraged to share their knowledge with each other.

Teacher B pointed out that her approach to teaching and learning of mathematics was by working from the known to the unknown where possible. She also indicated that she builds on learners' existing knowledge when starting a new chapter or topic. She also stated that after teaching a topic, learners are given examples of different types of questions, based on the topic. The teacher said she uses previous years' question papers to illustrate to the learners how the same question might be asked in different ways. She said she always tries to get learners to be part of the lessons and not to just sit down passively.

Teacher B pointed out that she did not do many questions from the textbooks, but working through old question papers had better assisted her teaching. The teacher claimed to engage learners during lessons by asking them to explain how they understood a particular question. By this way, she claimed that some learners would respond by agreeing or disagreeing and, in this way, their mistakes were highlighted. She stated that learners also discussed their work in groups.

One of the learners said that teacher B made use of different kinds of ways to solve a specific lesson, which makes the work easy to understand. Another learner indicated that teacher B's pace was sometimes too fast when providing an explanation of a lesson. Yet another learner reported that he always struggled to grasp new concepts at the beginning of a new chapter.

Out of 23 mathematics learners, 13 reported that they usually understood practical examples used in the classroom by the teacher, 7 reported that they seldom understood the examples, and 3 indicated that they always understood the examples.

Judging by the comments of the above learners, it appeared to struggle with the pace that teacher B used when explaining mathematics. It also appears that learners are battling to grasp mathematical concepts. They did admit that after practising their mathematical calculations, they were able to understand it better.

### **5.10.3.2 Physical science**

Both physical science teachers indicated that they were strict yet flexible (depending on the situation), so as to ensure that a culture of teaching and learning is maintained in the classroom. They would like their learners to be serious about their work. Both physical science teachers stated that they sought to create an interactive environment in their classrooms, where learners were expected to participate as individuals, as well as in groups, with the intention of obtaining optimal participation from them. One of the teachers pointed out that she sought to establish relationships of trust with learners and aimed to understand the learners' personal life problems.

Physical science teacher A reported that she was strict on discipline and mutual respect. She stated that she wanted learners to actively participate and ensured that she was approachable to learners. Both physical science teachers pointed out that they used similar approaches to teaching. Teacher A described her teaching style as cooperative and participatory and sometimes direct teaching (i.e. chalk and talk) is required. Teacher B described his approach to teaching as cooperative and promotes learners to ask questions. He pointed out that he strives not to explain large volumes of information at a time in order to make learning easier for his learners. James (1998:87) states that "asking learners questions in the course of teaching is a vital tool in every teacher's kit of teaching methods, at the same time it is a form of on-going assessment by which the teacher actively seeks information about students".

Both teachers indicated that they encouraged learners to participate during lessons by engaging them through problem-solving, frequently asking them (the learners) questions, and calling learners (volunteers) to the board to demonstrate and explain their homework calculations to the class. The teachers pointed out that they were able to do practical exercises (by demonstration) only if apparatus were available. McNeir (1993:1) affirms that the South African education system has been undergoing extensive restructuring since the advent of democracy. Coinciding with the advent of democracy in South Africa in 1994, an Outcomes-Based Education system was introduced. Introduced in 1998 and amended in 2001, this system asserts that all learners have the ability to succeed, and focuses on the acquisition of knowledge, skills, values, and attitudes, unlike the traditional practice that was based on content mastery only (McNeir, 1993:1). According to this paradigm, teachers are

expected to introduce real-life mathematics into classrooms, and help learners acquire skills that will prepare them to become life-long learners and critical thinkers.

Both teachers indicated that they try to make lessons interesting by using examples from everyday life that learners could relate to. Teacher B pointed out that it was important for learners to understand the requirements of the syllabus and for this reason, learners are guided as to the expected outcomes of the lesson. Both physical science teachers pointed out that they used the same techniques to attempt to promote critical thinking amongst their learners. They pointed out that they both posed frequent questions and problems to learners during lessons and learners are expected to arrive at solutions. In this way, learners are encouraged to participate in solving and discussing problems. The teachers indicated that they also used brainstorming and scientific investigations to assist with the promotion of critical thinking.

The physical science learners claimed to relate well to their respective teachers' style of teaching. These learners pointed out that teachers use examples that were easy to understand, and that they always laid the groundwork so that the work was easy to understand. They also claimed that the language was easy to understand and always clear. They also claimed that they did not have a problem with the practical examples used in the classroom by the physical science teachers, as most of them indicated that they always understood the practical examples used by their teachers.

Judging from the comments of the above learners, it is evident that the learners understood the physical science classwork when presented in a manner that "built" on learners existing knowledge. Being actively involved in the teaching and learning process proved beneficial to learners, as both teachers promoted involvement of learners in their classroom.

#### **5.10.4 Language usage**

According to Henderson and Wellington (1998: 35), for many learners, the greatest barrier to learning science is language. The problem is that like many other African countries, South Africa has developed science curricula and content on Western trends, and science is taught mainly in English or Afrikaans.

Out of forty six learners, forty five indicated they are being taught in their mother tongue, which is English and Afrikaans, and only one learner pointed out that she was not being taught in her mother tongue, which is isiXhosa. Forty five learners reported that in their science and mathematics classroom, the language used by the teacher was always easy to understand. All of the teachers from both schools pointed out that they taught in their mother tongue which was English and Afrikaans. However, one of the mathematics learners pointed out that when his mathematics teacher used a laptop to aid the teaching process, it confused him because of the English that was spoken while he was Afrikaans-speaking. Twelve of the forty six mathematics learners reported that the manner in which questions were asked in examinations confused them. They pointed out that they understood the content of the subject, but when questioned in an examination, they were unable to answer because the terminology used in examinations was unfamiliar to them.

#### **5.10.5 Assessment**

Assessment plays an integral part in curriculum implementation as it helps to diagnose learning problems, track learner progress, provide feedback to learners, and provide evidence of learners' level of achievement. According to Kelly (2004:126), "it is of the essence of good teaching that one should constantly be attempting to gauge the levels of pupils' learning in order to lead them to further development".

Both the physical science and mathematics teachers pointed out that they regularly assess their learners' progress. They claimed to use teachers use question and answer sessions before starting with any new work. They pointed out that they also use homework, formal as well as informal tests as means of assessment. Other means of assessment the teachers claimed to be using were exercises. After completing a lesson on a certain topic, these teachers indicated that an exercise would be given to assess the learners' understanding of the topic. Mathematics teacher A mentioned that she observed the way learners answer questions posed to them by her during a lesson as means of assessment. She also said that if a learner was eager to get on with the exercise given, it showed that they understood the lesson and were eager to see how they fair in the exercise.



If teachers are regularly assessing learners in order to keep track of their progress, then early detection of learning difficulties are supposed to be detected. From teachers and learners' comments about learner content knowledge, it is evident that there are discrepancies between subject matter learners are being taught and the knowledge that they actually hold.

#### **5.10.6 Learner support**

All forty six learners reported that they did receive extra notes and material from both their physical science and mathematics teachers in an attempt to enhance their learning, as well as to help them prepare for their examinations. The teachers said that they completed previous examination papers with the learners, and also availed themselves after school and weekends to offer extra and remedial tuition. All four teachers pointed out that this was done without remuneration. Principal A reported that he offered motivation sessions to Grade 12 learners at his school once a week.

The teachers reported that when learners experienced difficulties in either of the two subjects, the respective teachers had different means of supporting them. Mathematics teacher B reported that she always tried to find the root cause of the problem when learners experienced problems with mathematics calculations. She also pointed out that she always encouraged learners to discuss problems they had with the subject. Mathematics teacher A said that he tried to assist learners in problem areas by giving them extra exercises. Physical science teacher A reported that she initiated parental intervention, after discussing the problem with the learner. The teacher also indicated that extra classes were offered if the learner was interested, and the subject matter was then presented in a different way and made use of technology. If extra tuition did not help, the learner who struggled with schoolwork, would be referred to a tutor for individual attention. In view of teacher A and B comments above, it is evident that learners received additional support from both their physical science and mathematics teachers, as well as from their principal. Learners were being encouraged by their teachers and principal A.

#### **5.10.7 Difficulties experienced with regard to teaching and learning**

All four teachers were faced with challenges concerning teaching and learning of their particular subjects.

### **5.10.7.1 Mathematics**

One of the biggest challenges that mathematics teachers were faced with, was having to teach learners who lacked background knowledge. It appeared that learners were progressing from one grade to another with gaps in their learning. Teacher B reported that he experienced problems when he had to teach learners at Grade 12 level who did not have any Grade 10 mathematical background. He said these were learners who had changed the subjects they were enrolled for and had been receiving mathematical literacy instruction in Grade 10. Twenty out of forty six mathematics learners admitted to having gaps in their Grade 10 and 11 syllabus knowledge. This is worrying to the researcher because it means that these learners are being allowed to carry on with mathematics up until Grade 12 level without ever having mastered mathematics in the lower grades.

All four teachers reported that learners had no confidence in themselves when it came to their school work. This, to the researcher, is understandable, seeing that most learners have gaps in their learning knowledge.

Another challenge the two mathematics teachers faced, was related to the manner in which learners go about the learning process. Mathematics teacher A indicated that learners were not prepared to work on their own and they did not do homework given to them. Four of the forty six mathematics learners reported that they did complete homework given to them every day, while twenty two admitted that they did not complete the homework on a regular basis. Mathematics teacher B said that teaching mathematical concepts was not a problem. She reported that learning, however, was not at the desired level. She was of the opinion that learners did not put enough effort into their learning. She pointed out that learners were reluctant to practise mathematics calculations. She stated that learners merely wanted to sit back and listen, and expected to understand and succeed by doing so.

Considering the teachers comments above, it can be deduced that gaps in learning was a huge contributing factor to low success of teaching and learning in mathematics. Learners are being disadvantaged by being allowed to progress from one grade to the next with gaps in their learning. It is questionable that learners are expected to succeed at Grade 12 level without understanding fundamentals of the syllabus being taught in lower grades. It also appears that learners are not

committed to their schoolwork, and do not realise that continuous revision of the subject matter is vital in ensuring success in mathematics.

#### **5.10.7.2 Physical science**

Both physical science teachers reported that teaching learners who had gaps in their learning was challenging. These teachers, like the mathematics teachers, indicated that learners had low confidence levels of learning. Of the thirty eight physical science learners, twenty two confirmed that they did not feel confident in their ability to be successful in the subject because there were sections of Grade 10 and 11 syllabus that they did not understand. The physical science teachers reported that not having enough resources (no water in laboratories, few chemicals, insufficient apparatus) was a hindrance to the teaching and learning process. Both teachers said that learners battled with the mathematics part of the subject and consequently were unable to perform calculations in physical science. Both teachers also pointed out that because learners struggled with simple mathematics problems, this hampered the teaching and learning of physical science. Both physical science teachers also complained about learners who did not revise their school work and do homework.

The teachers raised concerns that learners did not work hard enough, and did not spend enough time revising the work covered in class. The teachers indicated that learners received homework on a regular basis, but not all of the learners completed homework regularly. Ten of the forty-six learners reported that they revised work covered in class every day, whilst eighteen learners indicated that they only revised schoolwork during the weekend, and quite a number of learners admitted that they revised work covered in class only before a test or examination. In view of the teachers and learners comments above, it appears that learners have the same attitude towards their physical science subject as to the mathematics subject. It seems as if learners are not committed to their physical science subject, and do not acknowledge that incessant revision of the subject matter is imperative in ensuring success in this subject.

Teacher A indicated that the physical science syllabus was very broad, and covered a wide range of topics. She felt that the timeframe allocated to the teaching of the syllabus was inadequate. Her argument was that high levels of thinking was required from learners, whose cognitive ability was not up to standard. The teacher also

stated that the Grade 12 physical science syllabus required the learner to have some level of general knowledge and to be “well read”, and up-to-date with current affairs, which is not the case with today’s learners. Teacher A pointed out that learners are only able to concentrate for approximately thirty minutes.

Judging from teacher A’s comments above, it can be deduced that learners did not read enough and lacked general knowledge.

Physical science learners reported that they struggled to understand the definitions used in physical science. Their concern was that it was not always easy for them to link physical science to daily life, and this was one of the reasons they were confused about the subject. They felt that their classes were not adequately equipped for practical work. Learners also reported that when faced with examination questions which were posed in a different way to what is usually asked in class by the teacher, they were unable to answer the questions. From these learners’ comments above, it can be deduced that learners did not receive enough exposure to physical science experiments in the laboratory. They were unable to relate to the abstract subject matter taught in class and comprehend it to reality.

#### **5.10.8 Teacher support systems**

The National Teacher Audit of 1995 showed that teachers in South Africa are in need of in-service training. As a result, the government of South Africa, with the support of Non- Government Organisations, is in the process of trying to attain measurable gains by upgrading teachers through in-service strategies (Legari, 2004: 28). Through such programmes, more focus is laid on teacher capacity development and related in-servicing (INSET) programmes; curriculum reform and outcomes-based activities; equity of access and quality of instruction; and transformation of management capacity for expediting open learning environments. They also provide teachers with skills for working under different conditions (Legari, 2004: 28).

During the interview with both principals at the two schools, they indicated that their District Office does not assist the school by providing learner-support-materials to their Grade 12 learners. They argued that there was more that their District Office could do to assist their schools in improving the Grade 12 pass rate. Principal A pointed out that subject specialists or advisors should have been more involved in the support of teachers, in order to lift the school standard, not only in the school, but

also in the province. The principal used workshops and Continuous Assessment (CASS) programmes to illustrate lack of involvement of District Officials. He said that at workshops and CASS programmes, these officials do not participate. He reported that during workshops, these officials would just do the introduction or welcome, and thereafter disappear. Principal A pointed out that there was no involvement from subject specialists as well.

During the interview with principal A, he made the point that the District Office needed to get all teachers on the same level at all schools, implying that it should provide support with regard to in service training of teachers and improvement of educational qualifications without compromising the learners right to education. He claimed that some schools rely on informal assessments like tests instead of formal examinations. He also made a point that some financially under-privileged schools did not write as many tests and examinations as they were supposed to because these schools could not afford to do so. Furthermore, he pointed out that some schools wrote tests, while other schools did not write tests. There should be standardisation of assessment of learners at all schools so that formal examination should not be replaced by informal assessment as it is the practice currently in most schools in the Eastern Cape.

Both principals felt that the District Office could assist their schools by providing support materials to both teachers and learners. Principal B suggested that stringent measures should be put into place when learners choose subjects at school. His argument was that only learners who obtained an average of more than fifty percent in science and mathematics in Grade 9 should be permitted to carry on with the subjects in Grade 10.

#### **5.10.9 Time lost during teaching and learning**

The four teachers pointed out that an important contributing factor to time lost during teaching and learning was continuously having to repeat topics that have been taught. They argued that learners' inability to recognise things they have done in previous topics led to time wasted as the teacher had to revise work already covered during teaching time. Furthermore, they argued that learners did not do their homework and therefore did not consolidate what was already taught, and this also contributed to time be wasted. These teachers also listed administration, emergency

staff meetings, workshops, parent consultations without appointments, time spent on discipline, absenteeism of learners (especially before and after public holidays), gaps in learning, school programmes, teacher strikes, teacher absenteeism, and trade union meetings arranged during school hours as other factors that contributed to time lost during teaching and learning. The two principals also concurred with the teachers as they both listed strikes, meetings during teaching time, accommodating parents who visit the school unannounced, and ill discipline of learners as contributing factors.

### **5.11 FACTORS THAT CONTRIBUTE TO LOW SUCCESS RATES IN SCIENCE AND MATHEMATICS**

Three of the four teachers indicated that learners have no vision for the future. They argued that since many parents are poor, learners do not see the need to study because their parents cannot afford tertiary fees (although learners are informed about bursaries which are available to them). They also mentioned that learners were not committed to working hard. They said that learners gave up too easily because they struggled to read a question and understand what is being asked.

Principal A said that poor subject choice was one factor that contributes to low success rates. His argument was that parents tend force their children to do subjects that they are not capable of doing. Those who are capable, he said, were not motivated to pursue the subjects because of lack of resources. He pointed out that the Department of Education could do more with special programmes like they had in the previous education system, (where subject specialists used to come to the schools to assist teachers with the difficult parts of the syllabus). He also indicated that teachers tend to focus on the easy parts of the syllabus and left the difficult parts out. Principal A mentioned that teachers were inclined to give less attention to the difficult part of the syllabus. Principal A therefore strongly felt that teachers needed more support in dealing with these parts of the syllabus.

Principal B also felt that learners under-achieved because they were merely doing subjects as per parents' request. Another factor that he believed contributes to low success rate, is the fact that learners were unable to read properly, which meant that they are unable to correctly interpret questions posed to them. He also mentioned lack of self motivation as another contributing factor.

## **5.12 SUGGESTIONS FOR IMPROVEMENT IN SCIENCE AND MATHEMATICS SUCCESS RATES**

Principal A said that if learners were well informed about the content of the subjects and the outcomes, possibilities of the subject, they would make informed subject choices. The same principal also pointed out that parents hold a belief that their children must do science and mathematics, and some of these learners are not capable of mastering the subjects. He said that some people shy away from mathematics because they have a notion that it is difficult, which is not the case.

Physical science teacher A felt that too much emphasis was placed on learner performance at Grade 12 level. She said that when learners got to Grade 12 it was too late for them to suddenly adopt a culture of working hard when it was not expected of the learner in lower grades. She also says that learners should be motivated, drilled, and encouraged to perform from primary school. Her argument was that it was too late to start working hard when they got to high school, as it is very hard to undo bad habits.

Principal A concurred with the sentiments of the teacher about too much emphasis is being placed on Grade 12 pass rate. He says that nothing was being said about the lower grades. Principal A's views was that teachers who work hard should be acknowledged and recognised financially, and when other teachers notice that they are being recognised financially and personally rewarded, they would also be motivated to work harder.

## **5.13 LIMITATIONS OF THE STUDY**

The following constraints complicated the gathering of data for the study:

- The time span that was available for the completion of the study posed a limitation to the data gathering, implying that time constraints within the confines of this study did not allow for the exploration of relevant information that fall within the ambit of the study.
- The problem of participants who lie deliberately could be a possibility.
- The fact that learners who have failed physical science and mathematics at grade 12 level were not included in this study, could be a shortfall because they might have shared valuable information and experience that could add value to the findings of the study.

- Because only Grade 12 learners were used in the study, exposure of different themes that might have emerged from lower grades were controlled.

#### **5.14 IMPLICATIONS FOR FURTHER RESEARCH**

On the basis of the experience gathered in this study, a number of recommendations can be suggested concerning future research in this field. Replication and possible enlargement of the study to incorporate other schools so as to determine if the findings can be generalised. The nature of the study could be expanded to include those learners who have failed mathematics and physical science in grade 12.

#### **5.15 CONCLUSION**

This chapter presented a discussion of the study's findings. It is evident that a number of factors contribute to learners' poor performance in the matriculation examinations. These factors are not absolutely related to the school environment. Learners who come from families of low socioeconomic status encounter additional barriers to learning, as compared to learners who belong to families of higher socioeconomic status.

The biggest contributing factor of low success rates in physical science and mathematics, is gaps in learning. Learners are being allowed to progress from lower grades to higher grade without ever mastering the knowledge and skills of the various subjects of preceding grades. The following section wraps up the discussion of the study by providing conclusions raised in relation to empirical finding, and suggestions and recommendations are espoused.



## **CHAPTER SIX**

### **CONCLUSIONS ANE RECOMMENDATIONS OF THE STUDY**

#### **6.1 FACTORS OF LOW SUCCESS RATE IN SCIENCE AND MATHEMATICS**

A number of factors have been reported pertaining to the poor performance of pupils in the matriculation examinations and in general (Kahn, 1995: 442). One important element in an endeavour to find solutions to the problems of poor performance by learners is to undertake investigations that will help inform stakeholders (Legotlo, Maaga, & Sebego, 2002: 115). This study has explored factors that contribute to the low pass rate in science and mathematics in selected schools in the Northern Areas of Port Elizabeth. The analysis and assessment of empirical research findings made reference to the theories exposed in the literature review. This final chapter therefore provides a conclusion of the major findings and finishes with some final thoughts about the research.

It can be concluded that there are indeed various factors that contribute to the low success rate in science and mathematics, and that these factors are not solely attributable to the school environment. These factors include access to resources, poor subject choice, numeracy and literacy skills, drawbacks of Grade 12 syllabus, socio-economic status, language usage, and insufficient content knowledge.

#### **6.2 ACCESS TO RESOURCES**

Qhobela and Rollnick (2010: 6) report that most schools are characterised by, inter alia, overcrowded classrooms and laboratories. It has emerged from the empirical findings that learners are unable to reach their maximum learning potential because of lack of resources. Provision of resources by the Department of Education to public schools as required by the syllabus is inadequate.

It is proposed that the Department of Education should prioritise equipping all schools that offer science and mathematics with relevant resources in order to improve the standard of teaching and learning of the physical science syllabus.

#### **6.3 POOR SUBJECT CHOICE**

The study has revealed that learners who do not have mathematical backgrounds are being forced enrol for science and mathematics instruction because of their subject stream. Parents also tend to force their children to do these subjects.

It is proposed that subjects streams should be reviewed by stakeholders (district officials, student governing body, and school management) and to ensure that the correct subjects are coupled together. Schools should advise parents and learners about subject choice so that learners are able to make informed decisions and do not end up enrolling for unsuitable subjects.

#### **6.4 NUMERACY AND LITERACY SKILLS**

The empirical findings of the study has revealed that learners enter high school with weak numeracy and literacy skills. These underdeveloped skills interfere with the teaching and learning at high school level because learners are unable to read, write and do simple science and mathematics problems.

It is recommended that early literacy and numeracy skills should be closely monitored in the lower grades so that learners can fully develop these skills. Effective instruction in early years is crucial in ensuring learners are able to master reading, writing, and arithmetic. Learners should be encouraged to read and this can only happen if schools have adequate and well resourced libraries. Early intervention is important for students who struggle with numeracy at lower levels in order for them to become successful learners. A sustained effort from the government, school District Offices and dedicated teachers will be needed.

#### **6.5 DRAWBACKS OF GRADE 12 SYLLABUS**

Aubusson and Watson (1999: 603) maintain that curricula and associated teaching methods often have difficulties when implemented across the nation. They say such difficulties may be exacerbated when the curricula and teaching approaches are imported or transferred from developed to developing countries. This, they state, may be a particular issue in the public schools in developing countries, because those schools are not well-resourced. South Africa's current curriculum policies, in their opinion, make new demands on schools and teachers, based on ideas that have been largely developed overseas. It emerged from the empirical findings that important components of mathematics have been removed from the Further Education and Training (FET) band mathematics syllabus, and this presents challenges to the teaching and learning of mathematics. The teachers reported that the outcomes of the Grade 12 physical science syllabus is difficult to attain due to lack of resources and unrealistic timeframes allocated to the completion of the

syllabus. They argue that the time allocated is too short to cover all topics intensively and does not do justice to the depth of information required of learners during final examination.

It is proposed that the Department of Education should prioritise equipping all schools that offer science and mathematics with relevant resources in order to improve the standard of teaching and learning of the physical science and mathematics syllabus. The science and mathematics syllabi should be revised by the Department of Education in order to assign sufficient time to the completion thereof. The mathematics syllabus should be reviewed in order to determine if all relevant topics are included in it.

## **6.6 SOCIO-ECONOMIC CONDITIONS**

The empirical findings of the study have established that there is a relationship between socio-economic status and educational outcomes. Living in poor socio-economic conditions directly affects academic success. Learners are faced with barriers to learning, which stem from their home living conditions that are not conducive to learning and studying. When parents are poor, they tend not to motivate their children. This in turn results in the child lacking confidence in their learning ability and therefore the child has no vision for the future. This lack of learner vision interferes with the teaching and learning process. Although encouraged by the teachers, there is lack of learner participation in the classrooms. Learners do not value education, and teaching this type of learner presents with challenges.

It is proposed that teachers be provided with professional development regarding social skills so that they may be better able to understand the barriers that learners are faced with, as a result of their home living conditions. If teachers have a better understanding of these barriers they will be empowered to assist with alleviation thereof. Community Centre Buildings should be made available to learners after school hours to use as study facilities because learners are unable to complete homework and study in homes that are not conducive to learning.

## **6.7 LACK OF PARENTAL INVOLVEMENT**

Omeregbe (2010: 176) points out that parental educational level is known as a factor positively related to children's academic achievement. He goes further by saying the

family is the main factor influencing the lives and outcomes of students and the educational level of parents is a powerful factor influencing children's academic success. He states that it has been established that generally, the educational level of parents is greatly connected to the educational attainment of their children. It emerged from the empirical findings that lack of good role models, parental involvement and support for learners is a huge contributing factor to learner failure. When parents are uneducated and poverty stricken, they are unable to be good role models and will therefore not habitually motivate their children to be successful. These children are thus not encouraged to succeed and so failure is not worrying to them. Parents also have no confidence that they can help their children with the learning process. This too presents difficulties to the teaching of these learners as teachers are not able to see the "fruits" of their hard work as far as these learners are concerned.

It is proposed that initiatives to assist parents with life skills be put into place by the government in order to empower parents to assist their children with decision making. Information sessions can be arranged by management of schools to inform parents about the importance of education, career paths their children can follow after school, bursaries that are available to learners, and so on. If parents are made aware of the fact that their children do not have to sustain the poverty cycle, they may do more to encourage and support them to be academically successful.

## **6.8 LANGUAGE USAGE**

Kasule and Mapolelo (2005: 605) state that language may be a source of learning difficulties in mathematics. According to Henderson and Wellington (1998: 35), for many learners, the greatest barrier to learning science is language. The empirical findings of the study have established that learners are unable to relate to the teaching of mathematics because of the pace and language used in the classroom. The language used in physical science and mathematics is confusing learners because it is language that learners do not use on a daily basis. Learners are unable to relate to the manner in which questions are being asked in examinations because the terminology is unfamiliar to them. Learners also struggle to understand definitions used in physical science.

It is proposed that learners should read more so that they can improve their language skills. Digital media can be used to make reading more interesting for learners at school. Teachers must advise parents to encourage learners to read at home. The Department of Education should ensure that books are made available and accessible to all schools through functioning libraries that contain extra interesting reading materials for learners.

#### **6.9 INSUFFICIENT CONTENT KNOWLEDGE.**

The study has established that learners' insufficient content knowledge is the main school associated factor that contributes to their low confidence level of learning and low success in academic achievement. This is not only a problem for learners, but it is also difficult for teachers to teach learners who lack adequate background knowledge. Learners are unable to make meaningful connections to work they are supposed to already understand as a result of them not mastering the subject at the lower grades. Too much emphasis is placed on Grade 12 pass rates, and as a result not enough is being done to motivate learners in lower grades.

It is recommended that the Department of Education employ more teachers to assist with teaching and motivation in lower grades. In this way, teachers will be able to recognise problems and special needs more readily and offer extra help before it escalates into bigger problems. Teachers need to ensure that learners are mastering the content knowledge in all grades by regularly assessing them. By doing this, teachers can keep track of learners' development in the various subjects and can ensure that learners master the subject matter before progressing to higher grades. The Department of Education can ensure that learners progress to higher grades with more knowledge and skills by increasing the pass rates of all subjects in all grades. District Officials must ensure that all schools are indeed attaining the outcomes of the curriculum by visiting schools to check progress levels. By doing this, officials can ensure that all learners are rightfully receiving the proposed instruction that is set out by the Department.

#### **6.10 INSUFFICIENT EXPOSURE TO THE SUBJECT**

Aubusson and Watson (1999: 604) maintain that importing of curriculum is likely to result in a curriculum that poorly fits the current educational environment in developing countries. They feel that communities in the rural parts of South Africa

may be further isolated from their children's learning of science since the curriculum may sound foreign to them (because it tends to be oriented to urban life and experiences). The findings of the study has established that learners are not able to link physical science to daily life, and this is another reason they are confused about the subject. They are unable to relate to the abstract subject matter taught in class and comprehend it to reality.

It is recommended that the Department of Education should ensure that all schools offering physical science instruction are adequately equipped with the necessary experimental apparatus to perform practical examples. The Department should assist schools in exposing learners to physical science by arranging excursions to institutions where learners can observe the practice of science so that they can link what they learn in the classroom to reality. Universities can assist by inviting physical science learners to the science departments for further exposure.

#### **6.11 FINAL CONCLUSION**

The biggest school-related factor that contributes to the low success rate of learners in science and mathematics is progression from one grade to another with inadequate content knowledge. Learners are being set up for failure by being allowed to progress to higher grades without mastering the content knowledge in lower grades. It cannot be expected of learners to be successful at Grade 12 level when they are entering this grade with weak foundation. Learners who come from families of low socio-economic status are faced with additional barriers to learning, which are not encountered by learners who live in superior socio-economic conditions. It is evident from the findings of this study that there are various factors that have negative effects on the academic success of learners. These factors are not exclusively related to teaching and learning and the school environment. The most powerful factor that contributes to the success or failure of learners is their home environment. Learners who are not motivated to succeed have no desire to do so.

Improving the success rates of science and mathematics for learners who reside in areas of low economic conditions goes beyond what can be achieved in the classroom. The school is not the only role-player that is needed in order for success to be achieved. The government, the community and, most importantly, the family,

must all be committed to working together as a team in an attempt to ensure a brighter future for the next generation.

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## APPENDIX A

### LEARNER QUESTIONNAIRE

Instructions to respondent:

1. You are not required to state your name in the questionnaire.
  2. There are no right or wrong answers. Please answer as honestly as you can.
  3. Where you are required to choose an answer, please place an **X** in the most appropriate corresponding box.
  4. Please answer all of the questions.
- 

1. What is your gender?

|        |                          |
|--------|--------------------------|
| Male   | <input type="checkbox"/> |
| Female | <input type="checkbox"/> |

2. How old are you?

3. Which career path would you like to follow after matric?

|          |
|----------|
| <br><br> |
| <br><br> |

4. Will it be possible for you to follow your desired career path with the exam results from class assessments that you are currently getting? Please explain.

|                  |
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| <br><br><br><br> |
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5. What are the factors that motivate you to learn?

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6. What are the factors that demotivate you to learn?

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7. Why have you chosen physical science as a subject of interest?

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8. Why have you chosen mathematics as a subject of interest?

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9. Do you have a physical science text book?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

10. Do you have a mathematics text book?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

11. Do you have access to a computer at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

12. How would you rate your computer literacy level?

|                            |  |
|----------------------------|--|
| I am not computer literate |  |
|----------------------------|--|

|  |  |
|--|--|
| I can perform only very basic computer functions   |  |
| I am able to work in different computer programmes |  |
| I am an advanced computer user                     |  |

13. Does your school have a library?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

14. Is there any science equipment at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

15. Is there a science laboratory at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

16. Are you being taught in your mother tongue (home language)?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

17. How would you rate the way your science teacher uses language in the class?

|   |  |
|---|--|
| It is always easy to understand the teacher           |  |
| It is easy to understand the teacher some of the time |  |
| It is easy to understand the teacher most of the time |  |
| It is difficult to understand the teacher             |  |

18. How would you rate the way your mathematics teacher uses language in the class?

|   |  |
|---|--|
| It is always easy to understand the teacher           |  |
| It is easy to understand the teacher some of the time |  |
| It is easy to understand the teacher most of the time |  |
| It is difficult to understand the teacher             |  |

19. How often does your physical science teacher show enthusiasm (excitement/eagerness) when teaching?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |
| Seldom  |  |
| Never   |  |

20. How often does your mathematics teacher show enthusiasm (excitement/eagerness) when teaching?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |

|        |  |
|--------|--|
| Seldom |  |
| Never  |  |

21. How often does your physical science teacher make you feel free to participate and express your opinions in class?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |
| Seldom  |  |
| Never   |  |

22. How often does your mathematics teacher make you feel free to participate and express your opinions in class?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |
| Seldom  |  |
| Never   |  |

23. How often do you understand the practical examples that your physical science teacher uses in class?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |
| Seldom  |  |
| Never   |  |

24. How often do you understand the practical examples that your mathematics teacher uses in class?

|         |  |
|---------|--|
| Always  |  |
| Usually |  |
| Seldom  |  |
| Never   |  |

25. How often does your physical science teacher come to class?

|                       |  |
|-----------------------|--|
| In class every day    |  |
| Usually in the class  |  |
| Seldom comes to class |  |
| Never comes to class  |  |

26. How often does your mathematics teacher come to class?

|                       |  |
|-----------------------|--|
| In class every day    |  |
| Usually in the class  |  |
| Seldom comes to class |  |
| Never comes to class  |  |

27. Does your school offer extra tuition (help) for physical science and mathematics?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

28. Do you receive any extra notes or materials from your science teacher to help you prepare for exams?



|     |  |
|-----|--|
| Yes |  |
| No  |  |

29. Do you receive any extra notes or materials from your mathematics teacher to help you prepare for exams?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

30. What is your average physical science mark?

31. What is your average mathematics mark?

32. How would you describe the physical science classroom mood?

|                   |  |
|-------------------|--|
| Warm and friendly |  |
| Cold and tense    |  |

33. How would you describe the mathematics classroom mood?

|                   |  |
|-------------------|--|
| Warm and friendly |  |
| Cold and tense    |  |

34. Does your physical science teacher encourage you to do well?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

35. Do you interact with your teacher and the other learners during physical science lessons? Give a reason for answer.

|  |
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36. Do you interact with your teacher and the other learners in your class during mathematics lessons? Give a reason for your answer.

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37. Do you feel your physical science teacher is committed to teaching you? Give a reason for your answer.

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38. Do you feel your mathematics teacher is committed to teaching you? Give a reason for your answer.

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39. How would you describe your relationship with your physical science teacher?

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40. How would you describe your relationship with your mathematics teacher?

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41. Are you able to understand the work your physical science teacher tries to explain during lessons? Please explain.

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42. Is there anything about the way your physical science teacher explains the work during lessons that confuses you? Please explain.

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43. Are you able to understand the work that your mathematics teacher tries to explain during lessons? Please explain.

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44. Is there anything about the way your mathematics teacher explains the work during lessons that confuses you? Please explain.

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45. Is there any physical science work from grade 10 or 11 that you still do not understand?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

46. Is there any mathematics work from grade 10 or 11 that you still do not understand?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

47. How often do you get physical science homework?

|             |  |
|-------------|--|
| Every day   |  |
| Most days   |  |
| Once a week |  |
| Never       |  |

48. How often do you get mathematics homework?

|             |  |
|-------------|--|
| Every day   |  |
| Most days   |  |
| Once a week |  |
| Never       |  |

49. How often does your physical science teacher check your homework?

|             |  |
|-------------|--|
| Always      |  |
| Most days   |  |
| Once a week |  |
| Never       |  |

50. How often does your mathematics teacher check your homework?

|           |  |
|-----------|--|
| Always    |  |
| Most days |  |

|             |  |
|-------------|--|
| Once a week |  |
| Never       |  |

51. How often do you revise physical science work done in class?

|                    |  |
|--------------------|--|
| Every day          |  |
| 2 – 3 times a week |  |
| Every weekend      |  |
| Only before tests  |  |
| Only before exams  |  |

52. How often do you revise mathematics work done in class?

|                    |  |
|--------------------|--|
| Every day          |  |
| 2 – 3 times a week |  |
| Every weekend      |  |
| Only before tests  |  |
| Only before exams  |  |

53. Are your parents/guardians able to help you with your physical science homework?

|     |  |
|-----|--|
| Yes |  |
| No  |  |







**APPENDIX B**  
**EDUCATOR QUESTIONNAIRE**

Instructions to respondent:

1. You are not required to state your name in the questionnaire.
  2. There are no right or wrong answers. Please answer as honestly as you can.
  3. Where you are required to choose an answer, please place an **X** in the most appropriate corresponding box.
  4. Please answer all of the questions.
- 

1. What is your gender?

|        |                          |
|--------|--------------------------|
| Male   | <input type="checkbox"/> |
| Female | <input type="checkbox"/> |

2. How long have you been teaching?

3. How long have you been teaching grade 12?

4. To what extent are you motivated to teach?

|                      |                          |
|----------------------|--------------------------|
| Strongly motivated   | <input type="checkbox"/> |
| Motivated            | <input type="checkbox"/> |
| Not motivated        | <input type="checkbox"/> |
| Strongly unmotivated | <input type="checkbox"/> |

5. What are the factors that motivate your teaching?

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6. What are the factors that demotivate your teaching?

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7. What is your highest academic qualification?

|                        |  |
|------------------------|--|
| Std 10                 |  |
| Bachelor's degree      |  |
| Honour's degree        |  |
| Master's degree        |  |
| Other (please specify) |  |

8. What is your highest professional qualification?

|  |
|--|
|  |
|--|

9. Are you currently furthering any of your studies?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

10. Are you receiving any in-service training for physical science/mathematics subjects that you teach?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

11. Which subjects and grades are you currently teaching?

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|  |
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12. What is the teacher/pupil ratio in your physical science/mathematics classes?

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13. What type of formal training have you received for the subjects that you teach?

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14. Do you have access to a computer at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

15. How would you rate your computer literacy level?

|  |  |
|--|--|
| I am not computer literate                         |  |
| I can perform only very basic computer functions   |  |
| I am able to work in different computer programmes |  |
| I am an advanced computer user                     |  |

16. Does your school have a library?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

17. Is there any science equipment at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

18. Is there a science laboratory at your school?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

19. Do you teach in your mother tongue (home language)?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

20. How would you rate your content knowledge with regard to the grade 12 subjects you teach?

|           |  |         |  |
|-----------|--|---------|--|
| Excellent |  | Average |  |
| Very good |  | Weak    |  |
| Good      |  |         |  |



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25. What difficulties do you experience with regard to the teaching of grade 12 science and/ mathematics?

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26. How would you rate your confidence level for teaching grade 12 subjects?

|                            |  |
|----------------------------|--|
| Always confident           |  |
| Confident most of the time |  |
| Confident some of the time |  |
| Never confident            |  |

27. Any other comments you may have about the grade 12 syllabus?

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28. What factors do you believe contribute to time lost during teaching and learning?

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29. How would you describe your teaching style?

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30. How do you approach the teaching of science and /mathematics at grade 12 level?

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31. What type of classroom management style do you maintain in your classroom?



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32. What is your reason for maintaining the particular management style you have chosen for classroom?

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33. How do you engage learners in the lesson during class time?

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34. How do you encourage learners to think critically?

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35. How do you assess your learner's level of achievement in a lesson?

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36. What type of learner support systems do you offer to grade 12s?

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37. How do you deal with your grade 12 learners who do not cope with your subject/s?

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38. Do you give extra help to learners after school hours?

|                           |  |
|---------------------------|--|
| Yes, with remuneration    |  |
| Yes, without remuneration |  |
| No                        |  |

39. Do you experience overcrowding in your grade 12 science and/ mathematics classes?

|     |  |
|-----|--|
| Yes |  |
|-----|--|

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|----|--|
| No |  |
|----|--|

40. What is the general performance level of the learners' you teach?

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41. What factors do you think contribute to your learners' particular level of performance?

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42. What in your opinion is the general motivational level of the learners you teach?

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43. What do you think contributes to your learners' specific motivational levels?

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44. Do you feel that the learners you teach work hard enough in your subject?

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|-----|--|
| Yes |  |
| No  |  |

45. Do you feel that your grade 12 learners spend enough time revising science and/ mathematics work?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

46. Do your learners always do homework you give to them?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

47. Do all of your grade 12 learners have textbooks?

|     |  |
|-----|--|
| Yes |  |
| No  |  |

48. Please explain the type of relationship you have with your learners.

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49. What in your opinion are the factors that contribute to learners' low success rate in science and mathematics?

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50. Any other comments you might have about low success rates of grade 12 learners?

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**THANK YOU FOR COMPLETING THIS QUESTIONNAIRE**

## **APPENDIX C**

### **INTERVIEW SCHEDULE: FOR PRINCIPALS**

Kindly assist by truthfully answering the following questions. This interview will be treated in a strictly confident manner.

1. How long have you been the principal of this school?
2. What academic qualifications do you have?
3. What professional qualifications do you have?
4. Do you receive any management-related in-service training?
5. Do you have access to a computer at your school?
6. How would you rate your computer literacy level?
7. Does your school have a library?
8. Is there any science equipment at your school?
9. Is there a science laboratory at your school?
10. What is the teacher/pupil ratio in your physical science classes?
11. What is the teacher/pupil ratio in your mathematics classes?
12. Do your physical science and mathematics teachers receive any in-service training?
13. How would you rate the motivation and interest of your physical science teacher/s?
14. How would you rate the motivation and interest of your mathematics teacher/s?
15. How would you rate the motivation and interest of your Grade 12 learners?
16. What factors do you believe contribute to time lost during teaching and learning?
17. "Outcomes-based education (OBE) forms the foundation for the curriculum in South Africa. It strives to enable all learners to reach their maximum learning potential."

Do you feel that learners are able to reach their maximum learning potential through OBE in science and/ mathematics? Please explain.

18. Does your District Office assist you by providing learner support materials to your grade 12s?

19. What in your opinion can your District Office do to assist your school in improving your grade 12 pass rates?

20. What type of learner support systems do you have in place for your Grade 12 learners?

21. At your own school, what are the factors that cause learners to fail science and mathematics?

22. What measures have you put in place to improve your school's poor science and mathematics exam results?

23. In your opinion, how can the low pass rate in physical science and mathematics be improved?

24. What do you think will be the solution to the high failure rate of science and mathematics?

25. Any other comments you might have about low success rates of grade 12 learners?